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USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 74

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USSR REPORT

MATERIALS SCIENCE AND METALLURGY

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CONTENTS

WELDING

MISCELLANEOUS

UDC 533.9

STUDY OF THE STRUCTURE AND PROPERTIES OF ALUMINUM MATRICES OBTAINED BY PLASMA DEPOSITION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 81 pp 90-95 manuscript received 12 Mar 80

SHORSHOROV, M. Kh., KUDINOV, V. V., KALITA, V. I. and BULYCHEV, S. I., Moscow

[Abstract] A study is made of the contribution of various mechanisms to the increase in strength in plasma-deposited aluminum with a low content of impurity elements. A comparison of the strength of pure aluminum and plasma deposited aluminum based on it was used to determine the contribution of oxides, while a comparison of plasma deposited pure aluminum and AD1 technical aluminum was used to determine the contribution made by a supersaturated solid solution of impurity elements or products of the decomposition of this solution. After plasma deposition, the microhardness of the pure aluminum is independent of the temperature of subsequent annealing, whereas the hardness of technical aluminum has a maximum after annealing at 240°C. For technical aluminum after cold rolling, there is an increase in microhardness for annealing at under 300°C. For highly pure aluminum after cold rolling the microhardness decreases greatly as the annealing temperature increases to 180°C, a result of the process of recrystallization. Microhardness decreases for an annealing temperature of over 225°C in hot rolled technical deposited aluminum, along with the yield point and tensile strength; there is a corresponding increase in relative deformation. Deformation at 20°C produces finer structural grains in the technical aluminum, relatively unchanged by subsequent annealing. The great increase in strength upon deformation of up to 20% results primarily from compacting of the material. At a certain level of deformation (over 60%) in the technical aluminum after plasma deposition there is a sudden increase in microhardness, apparently a result of a change in the mechanism of plastic deformation with high dislocation density. In general, aluminum oxides are found to have a positive influence on the mechanical properties of matrix aluminum due to the suppression of secondary and partial suppression of collective recrystallization in annealing. Plasma deposition can significantly improve the mechanical properties of aluminum containing alloying elements of low solubility. Figures 3; references 13: 8 Russian, 5 Western.
[46-6508]

UDC 669.71:621.777:620.17

CONDITIONS OF SUPERPLASTICITY IN THE 1201 ALUMINUM ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, Mar 81 pp 31-33

PSHENICHNOV, Yu. P., MAKAROV, V. D., GRIBOVA, N. K. and GUSEV, Yu. V.

[Abstract] Transition to superplasticity in the 1201 commercial aluminum alloy (6.2% Cu, 0.27% Mn, 0.2% Zr, 0.1% V, 0.07% Fe, 0.96% Zn, 0.05% Ti, 0.05% Si, 0.02% Mg) was studied over the 400-525° C temperature range and the $1 \cdot 10^{-3}$-$4 \cdot 10^{-2}$ s^{-1} range of strain rates. Ingots of this material were cast by the continuous process and then homogenized at 520° C for 12 hr. Strips of a 16 x 250 mm cross section were hot extruded from these ingots (extrusion factor 23.4) at 440-460° C with subsequent air cooling. Standard specimens 30 mm long and 5 mm in diameter were cut and mechanically tested in a tensile machine for the yield stress at 20% elongation, the maximum elongation, and the sensitivity to changes in the strain rate. The optimum conditions for superplasticity in this material were found to be a temperature of 500° C and strain rates within the $(2.2\text{-}4.4) \cdot 10^{-3}$ s^{-1} range. These conditions ensure dynamic recrystallization to a fine-grain polygonal structure with a high density of dislocations at grain boundaries and inside subgrains just before transition to superplasticity occurs. Figures 4; references 3: 1 Russian, 2 Western.
[66-2415]

UDC 621.9048.4:621.762:621.79

FEATURES OF CATHODE SURFACE LAYERS DURING ELECTROSPARK APPLICATION OF POWDER MATERIALS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 1, Jan-Feb 81 pp 32-34
manuscript received 14 Dec 79

PARKANSKIY, N. Ya., MAZUR, V. A. and GITLEVICH, A. Ye., Kishinev

[Abstract] The composition and properties of coatings when powdered materials are applied by electrospark coating was studied using steel samples coated with powders of Al, Ni, PGKhN80SR-4, ferroboral, SAP-3 and Mo, W and WC of technical purity. It was found that the layer formed by this technology consists of the following zones: a white zone, zones of interaction and the base zones which are subjected to the thermal action of the spark discharge. Composition of the white zone is determined by the applied material and its properties depend on the mode of treatment. If the discharge voltage is increased along with an increase in the voltage of the spark generator then the white zone is enlarged in thickness as well as the zone of interaction. At the same time the microhardness of these samples is reduced insignificantly. When steel St. 45 was coated with nickel the microhardness of the white zone was 192 kgf/mm^2 while the zone of interaction had a microhardness of 927-1145 kgf/mm^2 which corresponds to the microhardness of $FeNi_3$. Figures 3; references 6: all Russian.
[86-6368]

STRENGTH OF THE BOND BETWEEN POWDER-METAL COATINGS DEPOSITED BY THE ELECTRIC-SPARK PROCESS AND THE BASE MATERIAL

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 5, Sep-Oct 80 pp 74-75

PARKANSKIY, N. Ya. and RISHIN, V. V., Kishinev

[Abstract] An experimental study was made to verify the theory of a high-strength bond between a powder-metal coating deposited by the electric-spark process and the base material. The test involved tearing a conical dowel pin away from a coating layer according to a special procedure devised at the Institute of Problems of Strength (Academy of Sciences of the Ukrainian SSR). A dowel pin

of grade-45 steel was snugly inserted into a hole in a die (made of the same material) flush with the die surface. The latter surface, including the dowel face, were first polished with a grade M14 abrasive cloth and then coated with a layer of wear resistant grade PGKhN80SP-4 alloy powder, 100-150 μm thick for the shear tests and 250-300 μm thick for the bond tests. Both shear strength and bond strength were measured as functions of the spark-discharge energy over the 1.92-12 J range and found to increase correspondingly from 6.5 to 8.5 kgf/mm^2 and from 13 to 17 kgf/mm^2 respectively. This is attributed to an enlargement of the interaction zone due to a more intensive thermal action on both materials. The shear strength and the bond strength were also measured as functions of the coating thickness over the respective ranges, at the highest level of spark-discharge energy (12J), and both were found to decrease with increasing layer thickness: the shear strength down to 6.8 kgf/mm^2 with a 150 μm thick coating and the bond strength down to 13.6 kgf/mm^2 with a 300 μm thick coating. Metallographic examination and x-radiographic layerwise phase analysis revealed a transition layer of the $FeNi_3$ intermetallic compound. Figures 1; references 5: all Russian.
[28-2415]

UDC 621.357.75-415

NEW THIN SHEET ROLLED PRODUCTS WITH PROTECTIVE COATINGS

Moscow STAL' in Russian No 3, Mar 81 pp 72-74

PARAMONOV, V. A., candidate of technical sciences, Central Scientific Research Institute of Ferrous Metallurgy

[Abstract] This continuation of a discussion begun STAL'. No 12, 1980 (pp 1092-1098) describes the equipment used for continuous hot galvanizing of sheet steel, including heat treatment of the cold rolled metal with simultaneous preparation of the surface of the strip, application of the coating in a zinc melt, formation of the coating, straightening of the zinc-coated strip, chemical processing of the coating (passivation) and oil treatment. The Zhdanovsk Metallurgical Plant imeni Il'ich has started up the first domestic hot galvanizing unit with improved technology. During the next five years, a hot galvanizing unit with a capacity of up to 500,000 tons per year is to be constructed at the Novolipetsk Metallurgical Plant. The production of electrolytic galvanized sheets is to be increased greatly during the next few years, achieving homogeneity, high ductility and good adhesion of zinc coatings. A new technology of electrolytic galvanizing of steel strip has been developed at the Central Scientific Research Institute of Ferrous Metallurgy and tested at the Lys'venskiy Metallurgical Plant. Two industrial units are currently under construction at this plant, combining the processes of electrolytic galvanizing and application of polymers in a single production line. A new specialized aluminum coating line has been developed by the Ural Scientific Research Institute of Ferrous Metals and the Central Scientific Research Institute of Ferrous Metallurgy, involving application of aluminum powder in an electrostatic field with subsequent rolling and heat

treatment. The author's institute has also developed a process for production of thin sheet steel with aluminum coatings produced in a vacuum. A pilot scale installation has been constructed at the Lys'venskiy Metallurgical Plant. The first unit for the production of cold rolled strips coated with polyvinyl chloride film was put in operation in the USSR in 1973 at the Zaporozhstal' Plant. Several plants are to be set up for the production of steel and galvanized strip coated with polymer coatings during the 11th Five Year Plan. The production of structural materials with polymer coatings for the motor vehicle industry, cold rolled steel strips with two layer coatings 12 to 15 μm thick on one or both sides is to be undertaken during the next Five Year Plan as well. The coating consists of a thin sublayer applied from an aqueous solution of chromic acid, zinc powder and organic additives plus a layer of epoxy primer with a high content of finely dispersed zinc powder. The product, called tsinkrometall, has good corrosion resistance, salt resistance and can be easily stamped. It can be welded and painted by the usual processes used in the motor vehicle industry.
[72-6508]

UDC 621.762

WEAR RESISTANT TiC-Fe POWDER COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 80 pp 39-42 manuscript received after revision 29 Mar 80

NARVA, V. K., KALINICHENKO, V. M. and BEYLINA, L. M., Moscow Institute of Steel and Alloys

[Abstract] The outstanding features of TiC-Fe powder coatings are their hardness and high wear resistance. For a study of the powder coating technology and characteristics, two different mixtures, 30 vol.% TiC+ 70 vol.% Fe and 50 vol.% TiC+ 50 vol.% Fe, were deposited by the very economical high-speed (fraction of a second) electric-contact sintering process on hard (DPH550) low-porosity (0.45%) grade-45 steel. The coating hardness was measured as a function of the heat input (Joule-effect heat I^2t); its porosity (density) and bond strength were measured as functions of the welding time and pressure. The wear rate in abrasion tests in a friction machine as a velocity of 0.89 m/sec and under a pressure of 35 kgf/cm^2 was found to be 0.04 g/hr or 13 μm/hr off a 30-70 TiC-Fe coating and 0.02 g/hr or 10 μm/hr off a 50-50 TiC-Fe coating, compared with 0.09 g/hr or 18 μm/hr off quenched grade-45 steel, with a lubricant consisting of oil and quartz powder in suspension. Such coatings are, therefore, recommended for restoring worn parts of agricultural and other machinery. Figures 5; references 4: all Russian.
[61-2415]

UDC 621.762:620.17

STRENGTH OF SINTERED ZrN-Al_2O_3-Mo(W) COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 80 pp 84-88
manuscript received after revision 1 Mar 80

YEGOROV, F. F., Institute of Problems of Material Science, UkSSR Academy of Sciences

[Abstract] The strength and fracture characteristics of three binary composites--ZrN-Al_2O_3, Al_2O_3-Mo(W), Mo(W)-ZrN--were studied earlier. These composites are used for refractory electrodes for spot welding of high-carbon and stainless steels. Here the characteristics of ternary ZrN-Al_2O_3-Mo(W) composites were studied, particularly the dependence of their porosity and flexural strength on the sintering time and temperature. The disperaity of the two ceramic components in the raw powder mixture was 1 μm, the disperaity of the metal powder (molybdenum or tungsten) was 4-5 μm and its fraction was varied from 10 to 70 vol.%. Pellets were pressed and then sintered in a furnace under continuous heating at a constant rate, with subsequent isothermal soaking, in an atmosphere of pure argon or extra-pure nitrogen. The results of tests and fracture analysis indicate that the strength of the material increases with a higher molybdenum content, and much less so with a higher tungsten content. Unlike the strength of binary composites, moreover, the strength of ternary composites with more than 30 vol.% Mo is somewhat higher after liquid-phase sintering and short (15 min) isothermal soaking than after solid-phase sintering. Sintering in a nitrogen rather than argon atmosphere does not affect the strength and the phase composition of composites with molybdenum, but results in a partial transformation of the α-Al_2O_3 phase to a hitherto unknown cubic Al_2O_3 phase in composites with tungsten and thus results in a lower strength in this case. Figures 4; references 10: all Russian.
[61-2415]

UDC 539.4:669.24'26'28

INFLUENCE OF COATINGS ON MOLYBDENUM FIBERS ON THE PROPERTIES OF A COMPOSITE MATERIAL WITh A NICHROME MATRIX

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 17, No 1, Jan-Feb 81 pp 54-58 manuscript received 7 Aug 79

MAKSIMOVICH, G. G., FILIPOVSKIY, A. V. and FEDERENKO, V. K., Institute of Physico-Mechanics imeni G. V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] A study is presented of the possibility of inhibiting the process of growth of transient zones and increasing the strength characteristics of composite materials at elevated temperatures by application of protective coatings to the reinforcing fibers. The reinforced composites were produced by hot pressing of Kh20N80 powder in graphite press molds at 1473°K, 20 MPa, 15 minutes. The strengthening phase consisted of continuous molybdenum fibers ~80 μm in diameter. The volumetric fiber content was 20 and 30%. Metallographic analysis revealed that the transient zones form in the process of manufacture of the materials. Vapor-gas precipitation onto the fibers was used to apply thermodynamically stable coatings of titanium nitride, which supports good bonding of the fiber with the matrix. Strength testing indicated that at room temperature the coatings reduced the strength of the fibers. At 1373°K the strength of the fibers is practically the same with or without the coating. Flat specimens were made of reinforced sheet materials by stamping. Short and long-term strength testing were conducted at 293 and 1373°K, room temperature testing was conducted in air, and high temperature testing in purified argon. The use of protective coatings increased the heat resistance of the chrome-nickel alloy. The introduction of 30 vol.% molybdenum fibers increases the strength of the specimen at 1373°K by a factor of 11. Application of coatings to the fibers results in a still greater increase; the long-term strength increases greatly in the reinforced material. The use of titanium nitride coatings increased the tensile strength at 1373°K by almost 50%. Figures 4; references 12: 11 Russian, 1 Western. [88-6508]

ON THE QUESTION OF ELECTROCHEMICAL IRON-ZINC COMPOSITE MATERIALS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 5, Sep-Oct 80 pp 78-79

FILATOV, V. I., Kishinev

[Abstract] The feasibility of producing iron-zinc composites electrochemically, as substitutes for iron-nickel composites with the same properties and a particularly high wear resistance, has already been established. The process involves using an "organic electrolyte" such as methyl sulfate-chloride and corundum or silica as the second phase in suspension. A study was made of such a product using silica with a submicron dispersity as the second phase. Specimens were deposited on grade-3 steel and on grade-M00 copper substrates at 20°C.

Examination under a Stereoskan-150 electron microscope-microanalyzer has revealed that the second phase converts the fine-crystalline Fe-Zn sediment with a rough surface to a denser material with a smoother surface. The structure becomes honeycomb-like as the silica concentration reaches a certain level and then a more intricate one with a silica concentration above 20 kg/m^2. No conglomeration of silica particles to clusters larger than 0.1 μm has been found to occur. The presence of iron is small amounts of 0.3-1% improves the microhardness without substantially increasing the brittleness and the internal stresses. Raising the iron content up to 10%, by raising the current density in the electrolytic process up to 1000 A/m^2, results in a still better microhardness and a disappearance of the roughness honeycomb effect altogether. References 3: all Russian.
[58-2415]

UDC 669.017.12:541.12.017:536.421.4

SPORADIC DISRUPTIONS IN THE REGULARITY OF THE GROWTH OF EUTECTIC COMPOSITES

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 50, No 5, Nov 80 pp 1067-1073 manuscript received 6 Jun 79, in final version 6 Dec 79

BORSHCHEVSKAYA, D. G. and KUTSOVA, V. Z., Dnepropetrovsk Division, Institute of Mechanics, Ukrainian Academy of Sciences

[Abstract] The method of layer-by-layer microscopic analysis is used to establish that local disruptions of the regular plate growth of eutectic composites result from continuous branching of the eutectic phases in a colony. The following eutectic alloys were studied: Sn-Pb, Cd-Sn, Cd-Zn, Cd-Pb and Zn-Sn. Directed crystallization was achieved by the method of zone melting and the Chalmers method. Methods of chemical, linear and local x-ray spectral analysis were used to determine the content of the components in the initial eutectic and plate-like colonies in areas of regularity. It is found that a plate-like colony in Sn-Pb is formed and grows in the liquid state, rich in tin. This results in the accumulation of the "excess" component in front of the leading edge of growth of the colony and the development of concentration supercooling. When a certain critical supersaturation is reached, the phase based on the excess component grows in the liquid at a more rapid rate, leading to a loss of stability by the planar growth front. The excess phase grows out in front of the leading edge of crystallization, causing structural defects in the form of sporadic bands of disrupted regularity. The degree of regularity of the structure depends on the rate of crystallization, since it is determined by the degree of frontal supercooling of the melt. Figures 4; references 14: 7 Russian, 7 Western.
[67-6508]

UDC 621.762:621.793.6

COMPATABILITY OF CARBON FIBERS WITH A CARBIDE COATING WITH AN ALUMINUM MATRIX

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 80 pp 32-33

ISAYKIN, A. S., CHUBAROV, V. M., TREFILOV, B. F., SILAYEV, V. A. and GORELOV, Yu. A.

[Abstract] The chemical reactions taking place when silicon is used to form a silicon carbide between the aluminum matrix (AL9 aluminum alloy) and carbon fibers are delineated to show that silicon helps to prevent the formation of aluminum carbide in the composite material. It turns out that the silicon carbide formed from the 6% Si in the AL9 alloy effectively protects the carbon fibers from interacting with the aluminum melt which leads to increased strength properties of the composite as well as increased corrosion resistance by a factor of 3-4 times. References 5: 3 Russian, 2 Western.
[54-6368]

UDC 539.216.1:669.781'295:532.73

INTERACTION OF FIBERS WITH THE MATRIX IN THE TITANIUM-BORON SYSTEM

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 80 pp 25-26

PORTNOY, K. I., BOGDANOV, V. I., RUBAN, A. V. and FUKS, D. L.

[Abstract] The rate of interaction of boron with titanium alloys in the presence of additional elements is changed either due to a forcing back by the growing diboride of one of the alloying elements in the titanium matrix or as the result of the diboride stoichiometric composition change when the matrix is alloyed with elements which are dissolved in the diboride. Initially the reaction product contains all the elements of the matrix along with the fiber elements. Then in conjunction with thermodynamic requirements some of the elements are concentrated in the reaction product. The exchange of elements between the diboride and matrix, as a result of which the matrix in the vicinity of the diboride is depleted by the element having entered into the diboride composition and enriched by the element which is not contained in the diboride, approximates a system in an equilibrium state. The degree of reaction slowing depends on the rate of the diffusing element which enriches the matrix. In order to explain how the alloying of the matrix affects the homogeneity of the boron solid solution in titanium it is necessary to determine the change in mixing energy of the solid solutions in the Ti-B system when alloyed with Al, V and Si. If the alloying leads to an increase in the alloy mixing energy in comparison with binary alloys, then the solubility of boron is diminished and the region of solid solution homogeneity is narrowed, which creates thermodynamically unsuitable conditions for the formation of diboride. A decrease in mixing energy leads to the

opposite effect. The mixing energy of an interstitial solid solution can be determined as the difference between the energy of the alloy and the energy of the steady state (mixtures of the components). It is assumed that boron atoms occupy octahedral internodules in the titanium HCP lattice and the atoms of alloying elements replace the titanium atoms. References 7: all Russian. [54-6368]

UDC 669.71'781:519.211

EFFECT OF THE INTERFACE BOUNDARIES ON THE STRENGTH OF COMPOSITE MATERIALS WITH BORON FIBERS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 80 pp 22-25

SHORSHOROV, M. Kh., GUKASYAN, L. Ye. and USTINOV, L. M.

[Abstract] The essence of the theory explaining the effect of interface boundary strength on the strength of fibrous composites with brittle fibers, Al-B being typical, is presented. Modeling was done for two cases: 1) one having maximum interface boundary strength and failing by a noncumulative mechanism and 2) one having zero interface boundary strength and failing via a cumulative mechanism. One of the diagrams presented shows the relationship of composite material strength to interface boundary strength and revealed that the maximum strength of a material often can be achieved at some intermediate value of interface boundary strength but this strength is not equal to the strength of the matrix. This was confirmed by experiments using an Al-B composite with the matrix being plasma sprayed AD1 aluminum alloy. The best prospects for composite Al-B materials are D16 alloy in the quenched and hardened state and annealed ABM1 alloy. Figures 3; references 12: 7 Russian, 5 Western. [54-6368]

UDC 539.216.1:669.71.669.781

FEATURES OF DEFORMATION IN METALLIC COMPOSITES WITH BRITTLE FIBERS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 80 pp 19-21

FRIDLYANDER, I. N., and BRIBKOV, A. N.

[Abstract] The distribution and magnitude of residual strains on the surface and internal layers were determined in an Al-B composite while under bend testing in relation to the thickness of the materials and the nature of the bonding employed. Results showed that in contrast to ordinary materials the neutral layer of the composite during bending is almost always shifted to the side of

the internal radius of the material being bent with a primary distribution of stress deformations in the deformation site. The interrelationship of neutral layer displacement with the structural features of the composite and bend parameters was established. The character and conditions of failure upon reaching critical values of strain were shown and the conditions of bending metallic composites were determined for the case when the line of bend does not coincide with the fiber directions. Experiments were conducted where the bend angle and fiber direction differed and it was determined that it is possible to volume stamp Al-B composites in the manufacture, for example, of parts with double curvature as long as the deformation is done at elevated temperatures and slow bend rates. Figures 4; references 2: 1 Russian, 1 Western.
[54-6368]

UDC 621.74.032:669.715.677-15:539.4

INTERACTION OF CARBON FIBERS, COATED WITH TITANIUM CARBIDE, IN AN ALUMINUM MELT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 80 pp 26-29

KASHIN, O. A., OVCHARENKO, V. Ye., SALIBEKOV, S. Ye. and ZABOLOTSKIY, A. A.

[Abstract] When an aluminum melt is used to impregnate a carbon fiber skeleton to produce a composite material the aluminum does not wet the carbon fibers. If temperature is increased above 1100°C, wetting occurs but there is an intensive formation of Al_4C_3 which weakens the carbon fibers and structural stability of the composite. The study undertaken concerning this problem revealed that if titanium alloys (Ti-Cu, Ti-Sn) are used, which will produce an interaction between the titanium and carbon to yield TiC, the formation of Al_4C_3 is reduced. Unfortunately the rate of Al_4C_3 formation is faster than that of TiC so there is always some amount of Al_4C_3 present. To prevent or suppress the formation of aluminum carbide, it is necessary to produce a thin layer of stoichiometric titanium carbide, to soak the carbon fibers in the aluminum melt at lower temperatures (somewhere below 1000°C), and to diminish the aluminum chemical activity by some means such as alloying it with some element which will make it less susceptible to aluminum carbide formation. Figures 3; references 10: 7 Russian, 3 Western.
[54-6368]

UDC 669.7.15.677-15:532.73

EFFECT OF MATRIX COMPOSITION ON THE INTERACTION OF CARBON-ALUMINUM COMPONENTS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 80 pp 29-31

PORTNOY, K. I., ZABOLOTSKIY, A. A. and TIMOFEYEVA, N. I.

[Abstract] A study was made of the interaction processes that take place in the Al-C system and an experimental check was made of the results of theoretical calculations of the interaction of carbon fibers with an aluminum-base matrix which had been alloyed with silicon, manganese or chromium. It was found that if 1% Mn is added to the matrix there is no noticeable change in the interaction process. On the other hand if 1% Cr is added there is a sharp increase in the interaction process of the components. In oth cases there was an increased amount of aluminum carbide produced which weakens the carbon fibers and structural stability of the composite. The addition of silicon was found to be most beneficial as its presence decreases the amount of Al_4C_3 produced which leads to increased strength and corrosion resistance of the composite. Figures 2; references 4: all Russian.
[54-6368]

UDC 539.3:678.067

DISTRIBUTION OF STRESSES IN THE COMPONENTS OF COMPOSITES

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 1, Jan-Feb 81 pp 37-42
manuscript received 5 Feb 80

VOLKOVA, T. A., Sverdlovsk Architectural Institute

[Abstract] Based on a solution of the stochastic boundary value problem of the theory of elasticity with certain general limitations, equations are produced allowing calculation of the distribution of random stresses in the internal points of an n-component directionally reinforced composite with anisotropic components. Within the framework of the assumptions made, the calculation can be performed with any required degree of accuracy. As an example, a unidirectionally reinforced composite containing 40% reinforcement is studied. Equations are presented describing the distribution of stresses in the reinforcement, and a graph of the distribution of random stresses in the reinforcement of the composite is included. Figures 2; references 4: all Russian.
[73-6508]

UDC 669.721'781:620.193

CORROSIVE STABILITY AND ELECTROCHEMICAL PROPERTIES OF A COMPOSITE MATERIAL WITH A MAGNESIUM MATRIX

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 80 pp 33-35

TIMONOVA, M. A., SPIRYAKINA, G. I., STROGANOVA, V. F. and ZOLOTAREVA, L. A.

[Abstract] An investigation was made of the corrosion resistance and electrochemical properties of a composite consisting of MA2-1 magnesium alloy matrix reinforced with boron fibers produced by diffusion welding. Corrosion tests were conducted by total submersion of the composite in 0.5 and 0.005 normal NaCl as well as in a chamber with an artificial tropical climate. Electrochemical tests were performed in the 0.005 normal NaCl. From test data it was concluded that the corrosion stability of this composite is directly related to the technology of its production. The addition of chromium to plate the fibers significantly increases the corrosion resistance of the composite. Under tropical climate conditions the corrosion rate is the same as the rate of the sheet material. The composite with a natural film has the highest corrosion rate followed by the composite with chromium-plated fibers. The lowest rate of corrosion exists for the MA2-1 alloy with a natural film. It seems that the chlorine ions increase the corrosion rate and use of this composite is not recommended for coastal conditions. Figures 3; references 6: 5 Russian, 1 Western. [54-6368]

UDC 669.71'784:781:539.43

ACCUMULATION OF DAMAGE IN ALUMINUM-CARBON AND ALUMINUM-BORON COMPOSITES UNDER LOW-CYCLE DEFORMATION

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 80 pp 36-37

UTKIN, V. S., SALIBEKOV, S. Ye. and SOROKIN, N. V.

[Abstract] Al-B and Al-C composites were used to test the accumulation of damage in composites. The Al-B composite had an AD1 alloy matrix reinforced in one direction with boron fibers (approximately 45% by volume) produced by diffusion welding. The Al-C composite consisted of a matrix of silumin (Al-11% Si) reinforced with carbon strip (approximately 40% by volume) and was produced by impregnation under pressure. Tests of both composites were conducted by symmetric bending at 20-300°C with an applied vibration frequency of 110 cycles/min. Tests were also conducted in kerosene, industrial oil and 3% NaCl. Results of Al-C tests at normal and elevated temperatures showed that damage accumulation (free vibration damping decrement in a sample) increases with the number of cycles but the increase is more drastic at elevated temperatures, especially at 300°C.

It should be noted that a stress of 287 MPa was used. Kerosene had the effect of increasing damage accumulation. This is explained by the formation of surface cracks in the early stages of the tests. For Al-B composites the damage was only revealed in the matrix. Tests showed that crack nucleation on the sample surface starts only after a finite incubation period. If the maximum stress is increased the incubation period is shortened and the effect of medium on damage accumulation is amplified. Under a constant cyclic load the time of appearence of the first cracks is diminished. This is accompanied by a decrease in the rate of growth of existing cracks and number of cracks forming at the surface. As a result the rate of damage accumulation with time is also decreased. The effect of salt water on damage accumulation in the Al-B composite is analogous to that of kerosene but more intense. Al-C and Al-B composites are sensitive to the action of surface-active and corrosive media, in which increased cyclic stress leads to increased sensitivity. Figures 2; references 5: all Russian.
[54-6368]

UDC 539.3:678.067

DETERMINATION OF THE ELASTIC-PLASTIC PROPERTIES OF SPATIALLY REINFORCED COMPOSITES BY THE METHOD OF AVERAGING

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 1, Jan-Feb 81 pp 30-36
manuscript received 10 Jun 80

KREGERS, A. F. and TETERS, G. A., Institute of Polymer Mechanics, Latvian Academy of Sciences, Riga

[Abstract] A method is developed for the description of the deformation of a spatially reinforced composite with a matrix consisting of an elastic-plastic material. The structural element of the model studied is a unidirectionally reinforced cylinder consisting of a linearly elastic reinforcement element in an elastic-plastic matrix. The properties of the spatially reinforced composite are determined by averaging the deformations or stresses of structural elements assuming homogeneous distribution of stresses or strains. Three different spatial reinforced systems are studied as examples. The averaging method suggested is intended for description of the elastic-plastic behavior of a spatially reinforced composite; the equations produced are also suitable for a hybrid composite. Figures 5; references 11: 10 Russian, 1 Western.
[73-6508]

UDC 669.28.620.17:620.18:539.216.1

STRUCTURE AND PROPERTIES OF HEAT-RESISTANT MOLYBDENUM ALLOYS FOR REINFORCING COMPOSITE MATERIALS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 80 pp 40-42

LEVIN, I. B., VINOGRADOVA, V. S. and BULYGIN, I.P.

[Abstract] The effect of combined alloying of Zr, Ti, Nb and C on the heat resistance and structure of molybdenum alloys was studied for the purpose of increasing the strength properties of molybdenum fibers when used in a Ni-Cr matrix at operating temperatures of 1000-1200°C. The two basic approaches used were to create a heterophased structure and solid solution strengthening. It was found that in alloys of the Mo-Zr-Nb-C system the carbon and zirconium render the main influence on strengthening the heterophase alloys of this system. From the test results a molybdenum alloy containing (in %) 0.24 C, 0.89 Zr, 1.3 Nb and 0.16 Ti, was selected for further research. It was found that wire produced from this alloy possessed less heat resistance than rod of the same alloy, which was caused by the presence of coarse molybdenum carbide precipitations. An increased heat resistance in the molybdenum wire can be produced by mechanical-thermal treatment involving quenching, deformation and aging resulting in a heat resistance of up to 550-600 MPa in the 100-1100° temperature range. Figures 4; references 6: all Russian.
[54-6368]

UDC 539.3:678.067

DIFFERENCES IN MODULARITY OF COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 1, Jan-Feb 81 pp 23-29
manuscript received 9 Apr 80

LOMAKIN, Ye. V., Moscow State University imeni M. V. Lomonsov

[Abstract] An analysis is presented of the nature of the variation in deformation characteristics of composite materials as a function of the type of stress state. Equations from the theory of elasticity for isotropic and anisotropic bodies with varying modulus are suggested for description of the phenomenon of modulus variation. This variation in modulus refers to differences in the values of the corresponding secant moduli with linear approximation of the curved deformation diagrams of the composite materials of both fiber and granular structure. Experiments were performed with ARV graphite-based tubular composite specimens and glass-reinforced polyester resin specimens. The experimental studies showed that the deformation characteristics of materials with modulus variations change not only with a change in the direction of any main stress, but also if the stress

does not change its direction but the relationship between stresses is changed Satisfactory agreement is observed between the calculated values of deformation coefficients and experimental data. Figures 7; references 16: 13 Russian, 3 Western.
[73-6508]

UDC 669.7:539.43

FEATURES OF THE ACCUMULATION OF FATIGUE DAMAGE AND FRACTURE OF AN ALUMINUM-BORON COMPOSITE MATERIAL

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 81 pp 96-100 manuscript received 4 Sep 79

AREF'YEV, B. A., GUR'YEV, A. V. and NOSKO, I. N., Moscow

[Abstract] A study is made of the inelastic deformation of a fiber composite material and the related deviation from Hooke's linear law in order to determine the nature and mechanism of fatigue fracture of the material. Sheets of AD1 aluminum reinforced with boron fibers (45% by volume) 1 mm thick were produced by hot rolling, then electric-spark cut producing specimens 30 x 100 mm in size, oriented in the direction of the fibers, with 5 to 7 specimens used for each experimental point. Fatigue tests were conducted in tension at 325 cycles per minute. The matrix was removed with hydrochloric acid and the number of fibers which it fractured in a 20 x 20 mm area determined. The change in Young's modulus in the initial portion in the deformation curve was determined. The experiments showed that cyclical loading produced a continuous decrease in the rigidity of the material, manifested as a decrease in Young's modulus. Photographs of specimens are presented. The accumulation of fatigue damage in the material was related to damage to the fibers and to the matrix in two parallel processes resulting in breakage of the brittle fibers and exhaustion of the plasticity of the matrix. Figures 5; references 8: all Russian.
[46-6508]

UDC 669.516:669.71.715

EFFECT OF ALLOYING ON THE SOLUBILITY OF FIBERS IN ALUMINUM-BORON AND ALUMINUM-CARBON COMPOSITES

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 80 pp 131-134 manuscript received 11 Sep 79

PORTNOY, K. I., BOGDANOV, V. I., MIKHAYLOV, A. V. and FUKS, D. L., Moscow

[Abstract] Interstitial solid solutions of both aluminum-boron and aluminum-carbon systems are characterized by a limited solubility their homogeneity range being determined by the entropy on the one side and by the mixing energy on the

other side. The mixing energy in these systems is a positive quantity and, when increased, lowers the solubility within the homogeneity range. Here the total dissolution energy is calculated according to the theory of perturbations in the second-order approximation with respect to the pseudo-potential. The structure-dependent part of this energy is found as for a disordered substitutional solid solution, plus the exchange-co relation energy, the energy of the "free" electron gas, and the electrostatic energy. On this basis a model of multicomponent alloys is then constructed. Numerical calculations made for Al-B-X and Al-C-X alloys (X = Si, Mg, Cr), where X atoms replace aluminum atoms as in a substitutional solid solution and B or C atoms occupy octahedral interstices in the f.c.c. aluminum crystal lattice, indicate that the mixing energy is higher here than in a binary interstitial solid solution and increases with higher Si or Mg concentration but decreases with higher Cr Concentration. Accordingly, the solubility of boron and carbon in an aluminum matrix can be lowered by addition of silicon or magnesium and can be raised by addition of chromium. References 12: 8 Russian, 4 Western.
[60-2415]

UDC 541.66

EFFECT OF HEATING METHOD ON THE FEATURES OF HIGH-TEMPERATURE OXIDATION PROCESSES IN CARBIDE-GRAPHITE COMPOSITES

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian
Vol 17, No 3, Mar 81 pp 520-523 manuscript submitted 9 Oct 79

KOSTIKOV, V. I., RAKOCH, A. G., KRAVETSKIY, G. A., AYRAPETOV, B. L., POSOS'YEVA, G. D., DRUGOV, P. N. and SUBBOTINA, I. G.

[Abstract] The temperature relationship of the average oxidation rate in Zr-ZrC-C and Ti-TiC-C composite materials was studied in the 1170-1770°K range for different heating methods, and a search was made to find a means of increasing the heat resistance of these materials. When the Zr+ZrC+C composite is heated in an induction furnace the weight loss due to oxidation reaches a maximum at around 1470°K and then drops off with increased temperature but when heating is done in a resistance furnace the rate of oxidation and weight loss increase exponentially with elevating temperature. As a rule the transition of zirconium to accelerated oxidation can be associated with achieving a critical thickness of oxide film and the critical level of stresses in it which cause mechanical rupture of the oxide film. In relation to the synthesis conditions there is the possible formation of zirconium dioxide either from an excess of oxygen or a deficiency of oxygen of relatively stoichiometric composition. It was found that a portion of the oxide film, adjacent to the metal, undergoes n-conductivity while the film adjacent to the gas-film interface is characterized by p-conductivity. The transition of zirconium to accelerated oxidation can be associated with an electrical disturbance of the p-n-transition due to an increase in the time of the magnitude of the volume charge on both sides of it. During induction heating this phenomenon does not exist above 1370°K which is linked to the injection

of non-basic positively charged holes and basic (electrons) current carriers in the n-p-regions of the oxide film and, consequently, with the exclusion of the electrical breakdown of the p-n-transition. This prevents accelerated oxidation of zirconium. A similar phenomenon can be observed in the oxidation of zirconized graphite where the average rate of oxidation of this material is diminished by one-third above 1470°C in the transition from resistance to induction heating and is associated with the absence of transition of zirconium carbide and zirconium inclusions to accelerated oxidation. A completely different picture is observed during high-temperature oxidation of the Ti-TiC-C composite. During oxidation above 1170°K by induction heating there is some increase in weight, whereas in a resistance furnace there is a loss of sample weight which starts at 1170°K. With further increase in temperature the rate of oxidation remains almost constant. The lowering in the rate of oxidation of titanium alloys with temperature rise or increased soaking time can be explained by sintering and grain growth in the oxide especially in the surface layers. Similar growth condenses the stress oxide layer which makes it a diffusion barrier and causes a slowing in the oxidation rate. The decrease in oxidation rate of titanium-coated graphite is obviously associated with this mechanism. Figures 4; references 5: all Russian.
[85-6368]

UDC 621.762:669.018.4:537.523.4

SURFACE ALLOYING OF METALS BY THE METHOD OF ELECTROSPARK REACTION SINTERING OF POWDER COMPOSITES

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 1, Jan-Feb 81 pp 34-37
manuscript received 4 Mar 80

BURENKOV, G. L., RAYCHENKO, A. I. and KHRIYENKO, A. F., Kiev

[Abstract] The results of investigating the process of producing boride-powder surface coatings on sintered, cast and powdered metals by the electrospark reaction sintering (ESRS) method are presented. Powder mixtures of Fe+B_4C, amorphous Fe+B, Ni+B_4C and amorphous Ni+B were used in an ESRS device designed by the Institute of Problems of Material Science. Fe+B_4C powders were used in an ESRS test where it was noted that in a 20-second test the temperature of the mixture went from room to around 1200°C. In a second 25-second test the temperature reached 2000°C. The mechanism of ESRS, as determined from photographs taken every two seconds during the process, showed that in the initial step the mixture is subjected to the action of interparticle discharges. These discharges are the sites of exothermal synthesis reaction but the energy of these discharges is insufficient to initiate the reaction throughout the entire mixture volume. Simultaneously with the interparticle electric discharges the powder particles are heated by means of their electrical resistance. The start of the syntheses reaction for the entire sample is characterized by a sharp growth in mixture temperature where the temperature rise reaches 500°C/sec. The mixture is heated universally and uniformly, which provides a high rate and uniform formation of

borides. After the current is turned off cooling is very slow. The rate of sample temperature rise, total reaction time and product quality depend not only on the electrical characteristics of the process but also on the external mechanical pressure which by varying produces either a powder product or a sintered briquette. Figures 3; references 8: all Russian.
[86-6368]

UDC 621.762

DEPENDENCE OF THE PROPERTIES OF A CARBON-ALUMINUM COMPOSITE ON ITS CARBIDE CONTENT

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 81 pp 45-49 manuscript received 14 Jul 80

PORTNOY, K. I., TIMOFEYEVA, N. I., ZABOLOTSKIY, A. A., SAKOVICH, V. N. TREFILOV, B. P., LEVINSKAYA, M. Kh. and POLYAK, N. N., Moscow

[Abstract] A carbon-aluminum composite consisting of an aluminum matrix and reinforcing carbon fibers was tested for mechanical strength and corrosion resistance. Specimens of technical-purity (99.9%) aluminum with carbon ribbon (strength 2500 MPa, modulus of elasticity 28,000 MPa) had been produced by pressing (2-4 MPa) through the liquid phase at 670-760°C and soaking for up to 60 sec. Microstructural examination revealed acicular crystals of aluminum carbide Al_4C_3 up to 10 μm long and 1-2 μm in diameter along the interface. A quantitative analysis according to a special procedure (dissolving the matrix and the carbide in a solution of a copper salt, burning the evolved methane in a stream of oxygen, measuring the amount of carbon dioxide by the potentiometric method) yielded a carbide content from 1 to 5%, depending on the technological process parameters. The tensile strength, measured in flexure, was found to reach a maximum of 500-600 MPa at a 2-3% carbide content and then to drop fast with further increasing carbide content. This trend is attributed to the dual role of aluminum carbide, namely its mechanical binding action and crack channeling action. The corrosion resistance, measured in an aqueous 3% NaCl solution by the loss-of-weight method, was found to decrease consistently with increasing carbide content. This behavior is attributed to hydration of aluminum carbide (and of the aluminum in the galvanic Al-C pair) with a resulting formation of white aluminum hydroxide (and methane, which escapes). Figures 4;;references 6: 4 Russian, 2 Western.
[57-2415]

UDC 669.781-669.71:669.494

NATURE OF THE FRACTURE OF CAST BORON-ALUMINUM COMPOSITES (USING CORDS AS AN EXAMPLE)

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 81 pp 101-106 manuscript received 15 Jan 80

KHANIN, Ye. I., Moscow

[Abstract] The nature of the fracture of boron-aluminum composites was studied using case cords consisting of 7 fibers irregularly arranged in cross section. The fracture surface of the cords is illustrated in pictures made on a stereo scanning electron microscope. The fractographic studies showed that the nature of fracture of composite cords is determined by the material of the matrix. Matrices consisting of AD-1, AD-33 and AK-8 were studied. When AD-1 is used, the nature of fracture depends on the level of kinetic loads. At the minimum level the fracture occurs through a cross section perpendicular to the fibers and is reminiscent of a "weakest link" fracture model. When AD-33 of AV is used, the nature of the fracture at all load levels occurs in different planes as a result of formation of transverse and longitudinal cracks, the longitudinal propagating either along the fiber-matrix division boundary or through the matrix. In AK-8, the "weakest link" model is once again seen, regardless of the level of critical stress. Low strength, highly plastic AD-1 alloy achieves the highest overall value of tensile strength of the boron-aluminum composites. Figures 4; references 4: 3 Russian, 1 Western.
[46-6508]

UDC 541.451

INFLUENCE OF IONS OF SCANDIUM, COBALT AND CERIUM ON FERRITE FORMATION IN A LITHIUM MATRIX

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 4, 1981 pp 845-847 manuscript received 21 Jul 80

BONDAREV, V. Ye. and KAZVINI, N. D.

[Abstract] An experimental study was made of the influence of activating additives Sc_2O_3, CeO_2 and CoC_2O_4 on the rate of decomposition of an oxide lithium matrix at 500°C as a function of concentration of the activating ions introduced. This study was conducted on specimens of ferritic mixtures of standard oxides. The effectiveness of the process of decomposition of the mixture was estimated on the basis of the weight loss of the matrix. An anomaly was observed in the slowing of decomposition of the lithium oxide matrix following the addition of CoC_2O_4. As various activator ions are introduced to the ferritic matrix it is necessary to consider not only the physical structural parameters but also the influence of ions introduced on the process of thermal decomposition of the ferritic composite. Figures 4; references 11: 7 Russian, 4 Western.
[53-6508]

UDC 620.197

POSSIBILITY OF INCREASING THE CORROSION RESISTANCE OF TITANIUM BY IMPLANTATION OF PALLADIUM IONS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 5, 1981 pp 1129-1133
manuscript received 9 Sep 80

TOMASHOV, N. D., GUSEVA, M. I., FEDOSEYEVA, G. A., GORODETSKIY, A. Ye., ZAKHAROV, A. P., BOGOMOLOV, D. B., CHERNOVA, G. P., VLADIMIROV, B. G. and IVANOV, S. M.

[Abstract] A method of ion implantation of palladium is used to increase the corrosion resistance of titanium. The influence of the radiation dose on the phase composition and structure of the surface layer, concentration of implanted palladium and distribution of embedded palladium ions in depth are studied, as well as the electrochemical and corrosion behavior of the palladium-enriched titanium specimens. The results of x-ray structural analysis of the specimens are presented. Electronographic studies of the structure of the surface revealed significant changes in the phase composition of the surface layer in the process of bombardment with palladium ions. As the dose was increased from 10^{16} to 10^{17} cm^{-2}, a gradual enrichment of the surface layer with palladium is observed with a change in the phase composition of the surface from the formation of compounds of titanium with palladium to the formation of a metallic palladium film on titanium. After corrosion testing, the specimens bombarded with the heaviest doese of palladium still were found to contain palladium in their surface layers. The method of ion implantation is found to be an effective method of increasing the passivation and corrosion resistance of titanium. The optimal conditions of bombardment were found to be $5 \cdot 10^{16}$-$5 \cdot 10^{17}$ cm^{-2}, ion energy 20-100 keV. This dose level increases the corrosion resistance of titanium by a factor of more than 10^3. The duration of bombardment is 7-14 minutes. A conveyor apparatus has been developed for this purpose, allowing a surface of about 1 square meter to be treated in about 100 minutes. Figures 4; references 10: 6 Russian, 4 Western.
[44-6508]

UDC 539.385:669.721.5

STUDIES OF THE GROWTH RATE OF FATIGUE CRACKS IN MAGNESIUM ALLOYS AT ROOM TEMPERATURE AND LOW TEMPERATURES

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 80 pp 18-23 manuscript received 10 Aug 79

SERDYUK, V. A., Khar'kov, Physical-Technical Institute of Low Temperatures, Ukrainian Academy of Sciences

[Abstract] Five magnesium alloys with various phase compositions were studied: IMV6, MA2-1, MA15, MA12 and MA21. Specimens 1 mm thick were deformed by cantilever bending at 750 cycles per minute with a constant deformation amplitude of $\bar{\varepsilon}=\pm 0.0034$. The specimens were tested in a vacuum, at room temperature and at -135°C. The growth of fatigue cracks on the surface was studied by means of an optical microscope, with crack length measured by the decrease in load during the process of crack growth. Replicas of fracture surfaces were examined on an electron microscope. The variation in crack growth rate as a function of stress intensity at 20 and -135°C can be described by the function $d\ell/dN=CK^n_{max}$, where C and n are constants only for certain areas of K_{max}, depending on the composition of the alloy and the test temperature. The curve of $d\ell/dN=f(K_{max})$ has a bend point for MA2-1, MA15 and MA12 alloys at both temperatures. For IMV6 and MA21 the curve has two bend points which increase slightly as temperature drops. The MA2-1 and IMV6 alloys have the greatest resistance to fatigue crack formation and growth at both temperatures, and MA21 and MA12 have the least. Figures 4; references 12: 9 Russian, 3 Western.
[69-6508]

UDC 669.721'884:620.17:620.18:620.162.2

EFFECT OF SUPERPLASTIC DEFORMATION ON THE STRUCTURE AND PROPERTIES OF MA21 MAGNESIUM-LITHIUM ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, Mar 81 pp 33-36

KAYBYSHEV, O. A. and SALIKHOV, R. R., Ufa Aviation Institute

[Abstract] A study of MA21 magnesium-lithium alloy (8.0% Li, 5.2% Al, 4.7% Cd, 1.4% Zn, 0.21% Mn) was made to determine the dependence of its structure and mechanical properties on the treatment. The distribution of alloying elements in the structural matrix was revealed under a Neofit-2 optical microscope and a Tesla BS-540 electron microscope; after etching with a 0.5% or 30% solution of nitric acid in ethyl alcohol, their quantitative determination was made with a Samesa MS-43 x-ray spectral microstructure analyzer. Hot forged specimens were subjected to standard treatment (heating to 280°C, deformation, air cooling), thermal hardening (quenching from 350°C, natural aging), and to superplastic deformation. Results of mechanical tests performed after 2 weeks, 2 months, 6 months and 2 years indicate that superplastic deformation improves the strength characteristics, especially the toughness, of hot forged material more and stabilizes them for a much longer time than do the other treatments. Superplastic deformation was found to produce a homogeneous microstructure with a uniform precipitation of excess phases and a uniform distribution of alloying elements. Figures 1; references 7: all Russian.
[66-2415]

GOALS FOR POWDER METALLURGY CITED

Kiev PRAVDA UKRAINY in Russian 3 Feb 81 p 2

[Article by V. Trefilov, vice-president of the UkSSR Academy of Sciences, academician of the UkSSR Academy of Sciences, chairman of the Council on Powder Metallurgy affiliated with the USSR State Committee on Science and Technology, director of the UkSSR Academy of Sciences Institute of Problems of Material Science: "Powder Metallurgy's Today and Tomorrow"; passages enclosed in slant-lines printed in boldface.]

[Text] /"Based on the use of achievements of science and technology:... to increase the production of new structural materials, coatings and items based on metal powders, powder-alloys and high-heat compounds."

From the plan of the CPSU Central Committee for the 26th Party Congress/

Items and components of diverse equipment created using powder metallurgy methods operate reliably under the most extreme conditions. Since our institute is the leader on problems of powder metallurgy, composite materials and powder coatings within the country, I would like to provide an evaluation of the state of affairs and the future for the development of this and several related industries.

Metallurgical and machine building production are organically united in powder metallurgy, while blast furnace and steel smelting conversions, rolling and metal cutting, i.e., complex, energy-intensive, ecologically "dirty" processes characterized by large losses of heat and metal are excluded from the production chain. The powders may be obtained either directly from ores or from mill trimmings, slag and other wastes of metallurgy, with subsequent pressing and baking into finished items. It is a highly profitable production process: the coefficient of metal use in it is high, labor intensiveness is diminished and labor productivity is increased by at least a factor of two.

For example, in recent years, production of composite reinforced materials for modern machinery has been developing at a rapid pace. The use of new methods for producing coatings, including powder coatings, is expanding. These coatings will extend the service life of bearings and other components and mechanisms

by many times, and they will preserve tools and will protect ship hulls, offshore drilling structures, metal supports for high-voltage electric transmission lines, bridges, chemical and other equipment from corrosion.

Although application of powder coatings substantially extends the service life of machines and equipment, many ministries still do not heed the constant demand to study this matter seriously. At the All-Union Conference on Powder Metallurgy which was held last fall in Kiev, the president of the USSR Academy of Sciences Academician A. P. Aleksandrov specified the cause of this lack of interest: /how much time one or another machine should function is not regulated for practical purposes, and the machine building plants are not economically interested in the service life of their products.

In our opinion, such measures must mandatorily be provided for in the fourth section of the plan "Fundamental Trends."

It is necessary to express concrete measures within this document which are directed to the end that enterprises producing diverse machinery not suffer economically from reduction of its metal content (and weight) because of the notorious planning "in tons," which it has long been time to do away with. Meanwhile many industries suffer from this, including powder metallurgy./

The interest of many of the trends in technology has risen sharply in high-heat compounds (carbides, nitrides, borides, silicides etc.), which possess valuable properties. These compounds, many of which help conserve scarce tungsten, are used in the most diverse sectors. Now we can also create superfine grained materials which are impossible to produce in general using traditional metallurgy and metal shaping methods. /Paths for resolving one of the most difficult problems of materials technology for the age, the creation of a high-temperature, heat-resistant and other structural ceramic material for the needs of modern technology are opening./

In the work directed toward development of powder metallurgy, the UkSSR Academy of Sciences Institute of Problems of Material Science is collaborating with the Brovarskiy Powder Metallurgy Plant, the UkSSR Academy of Sciences Institute of Electric Welding imeni Ye. O. Paton, the USSR Academy of Sciences Institute of Metallurgy and the "Tulachermet" Association, the All-Union Scientific Research Institute of Light Alloys and other organizations.

We occupy the foremost positions based on the scientific and technical potential in this sector; however we are still lagging behind a number of the leading foreign countries, based on production volumes. /A special purpose scientific and technical program, in which more than 200 organizations of more than 50 ministries will participate, should eliminate this lag.

We consider the following to be necessary in the fourth section of the plan "Fundamental Trends" in those places where the tasks of heavy and chemical machine building and electrotechnical and machine tool building industries are enumerated: to add a supplement, having included an instruction concerning significant expansion of production and substantial improvement of the technical and technological level of equipment for powder metallurgy enterprises./

Powder metallurgy can do much. However, much must still be done, not only so that scientific ideas and production developments can be brought to realization in industry as rapidly and efficiently as possible, but also to develop them constantly during the production process. Therefore /our Institute supports the propositions contained in the speech of A. Gayduchenko, chief engineer of the Brovarskiy Powder Metallurgy Plant, which was published in one of the sets of materials from discussion of the plan "Fundamental Trends" (PRAVDA UKRAINY, 23 Dec 1980) concerning the strengthening of the scientific and production potential of this most important enterprise in the industry.

We propose in the first stage to organize a branch of the special design-technology office of the UkSSR Academy of Sciences Institute of Problems of Material Science based at the Brovarskiy plant./ Improvement of the manufacturing processes for producing powders and items from them, creation of efficient methods of production control and development and incorporation of better equipment and production lines should become the main concerns of this branch. /Subsequently, this branch may serve as a basis for organization of an industry Institute of Powder Metallurgy./

9194
CSO: 1842/48

EXPANSION OF POWDER METALLURGY URGED

Moscow TRUD in Russian 22 Jan 81 p 2

[Article by A. Manokhin, general director of the Tulachermet Scientific-Production Association, director of the Institute of Metallurgy imeni A. A. Baykov, Lenin Prize and State Prize recipient: "Steel Without Rust: What Is Impeding the Development of Powder Metallurgy?"]

[Text] Science has found effective methods of extending the life of metal. One of these methods is powder metallurgy. Scientists and workers at the Tulachermet Scientific-Production Association, working together with the USSR Academy of Sciences Institute of Metallurgy imeni A. A. Baykov, the Electric Welding Institute imeni Ye. O. Paton and the Institute of Problems of Materials Science of the Ukrainian SSR Academy of Sciences, the Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin and others, have created a large family of powder materials which will make it possible greatly to increase the useful life of metal. At the present time a facility for producing alloy powders is under construction in Tula on the grounds of the Tulachermet NPO [Scientific-Production Association].

One can scarcely exaggerate the importance of this work. Last year expenditures on the manufacture of automotive spare parts totaled approximately 2 billion rubles. More metal was expended in their manufacture than would be required for building new vehicles. If one figures how much iron and steel is lost to wear and corrosion, that other scourge of industry, the figures will be even more impressive. For the country as a whole, annual losses are equal to the production of the world's biggest metallurgical enterprise -- the Magnitogorsk Combine.

Every ton of powder utilized in machine building to harden parts makes it possible to double, triple their service life, and sometimes extend it even 10-fold! The service life of engine crankshafts, shafts of various pumps, engine cylinders for diesel locomotives, plus many other parts and assemblies is greatly increased. Employment of high-temperature corrosion-resistant coatings opens up great possibilities. Protecting water wall tubes on the steam boilers at the Yayva GRES more than doubled their service life and saved the Permenergo system 2 million rubles per year. Metal spray coating blast furnace tuyeres doubled their life and saved 104,000 rubles on the furnaces of the Tulachermet NPO.

The possibilities of powders are inexhaustible. If the legs of offshore oil rigs are coated with aluminum, their service life will increase 10-fold. The same

technique can be used to protect against corrosion bridge girders, power line towers, pipeline supports, structural members, docks, ship hulls, etc.

It is not surprising that the party and government are paying considerable attention to powder metallurgy. The CPSU Central Committee draft "Principal Directions of Economic and Social Development of the USSR for 1981-1985 and for the Period up to 1990" states: "Increase production of new structural materials, coatings and products based on metal powders, powder-alloys, and refractory compounds."

A considerable gap has already formed between the production of powders and the potential for their application. Production of powders has been placed on a broad industrial foundation. Equipment for applying powders is manufactured in small series, which are far from meeting the needs of the nation's economy, however. Indeed, what is the benefit of producing 125 plasma units at the Barnaul Machinery and Equipment Plant if as many as 600 units are needed right today? This gap will become even wider a year hence, with a sharp increase in production of powders. USSR Gosplan should specify the machine building ministries responsible for building automated production lines, industrial robots and other equipment essential for the extensive adoption of coatings.

In recent years the Institute of Electric Welding imeni Ye. O. Paton of the Ukrainian SSR Academy of Sciences has developed an excellent group of equipment for plasma coatings. It has proven to be highly reliable, boasts high productivity and excellent quality. Equipment of this quality should be given priority for large-series production.

It seems advisable to establish at USSR Gosplan an intersectorial department which would coordinate comprehensive solution of problems connected with the development of powder metallurgy and expansion of the sphere of application of its products. It should synthesize the know-how of the country's leading enterprises, determine the main and priority development tasks, the thrust of scientific research and development and, finally, plan securement of material-technical resources for those branches engaged in the production and utilization of powders.

New forms of cooperation among designer, scientific, construction and production subdivisions are needed for accomplishment of the tasks specified by the party in the CPSU Central Committee draft document for the 26th CPSU Congress. Unfortunately, at the present time we must state that no unified cooperation mechanism has been set up. Year by year powder metallurgy is acquiring the attributes of an industrial branch. It needs the entire production-economic chain characteristic of any modern complex servicing the national economy. It is high time to form design and engineering offices which will work on the development of high-productivity facilities for applying coatings, industrial robots, mechanized and automated lines, monitoring instruments, etc.

Presently more than 100 enterprises are collaborating with our association in matters pertaining to increasing wear resistance, heat resistance, and fighting corrosion. Leading Tulachermet experts travel out to enterprises to give practical assistance, set up specialized spray coating sections at these enterprises, and conduct extensive methodological and consultation work.

We believe, however, that this is only part of the solution. The problem of protective coatings requires highly specific knowledge and skill on the part of scientific, engineer and worker cadres. And yet specialists are being trained by only one higher educational institution in this country -- the Moscow Aviation Technology Institute. This is very little even for the central region, not to mention such vast regions as Siberia and the Far East, where rapid growth of powder metallurgy is planned.

Many academic and scientific research institutes are working on this problem. But each institute works on solving only narrow branch problems. There is no scientific establishment which would handle the entire aggregate of problems connected with powder metallurgy and its application. Such an institute is needed.

In particular, it is high time for science to move to a new and higher level. Scientists at the Institute of Metallurgy imeni A. A. Byakov and the Tulachermet NPO have amassed certain experience in hardening a number of parts and assemblies. Now it is necessary to build machinery with an extended service life, which will be achieved by employing an entire aggregate of metal protection measures. This project requires the enlistment of specialists in the most diversified fields of science and technology. It is essential to know the list of parts which determine a machine's time between overhauls, working conditions of parts and assemblies, and the most efficient method of hardening them.

Experience suggests that the task of increasing the service life of various machinery severalfold is quite realistic. In our opinion the USSR State Committee for Science and Technology should establish in the near future intersectorial innovation brigades for implementing specific programs pertaining to this problem. It may even be necessary to free a number of specialists from their principal job for the period of accomplishment of the assigned task on a given concrete mechanism, structure, machine, engine, etc.

Unquestionably this is a complex matter. It will not be accomplished in a month or year. But it must be done without delay. The benefits are unquestioned.

3024
CSO: 1842/39

UDC 621.793.7

DEPENDENCE OF THE QUALITY OF COATINGS DEPOSITED BY THE GAS-DETONATION PROCESS ON THE VELOCITY OF THE SPRAYED SURFACE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 81 pp 34-37
manuscript received 26 Jun 80

LIVSHITS, M. I., KHARLAMOV, Yu. A., SHORSHOROV, M. Kh. and KAPUSTYAN, E. N.
Zaporozhye Industrial Association "Motorostroitel'", Voroshilovgrad Institute of Machine Design

[Abstract] Surfaces of Kh17N2 (Cr 17 - Ni 2) steel were coated with the hard VK-15 titanium alloy by the gas-detonation process, after being shot blasted with electrical-grade corundum, with the sprayed surface traveling in a reciprocating motion past the stationary detonator gun 185 mm away. The gas mixture contained oxygen (1.92 m^3/hr), acetylene (1.5 m^3/hr) and nitrogen (1.2 m^3/hr). With the detonator gun shooting at the fixed rate of 2.15 times per second, only the velocity of the steel plates was varied: from 0.9 to 26.8 m/sec. The utilization factor was measured as the ratio of mass of the coating layer (P_2-P_1 mass of a plate after and before treatment, respectively) to mass of the coating powder (P_3-P_4 mass of the spray barrel before and after treatment, respectively). Measured also were the coating quality indicators. The results indicate that increasing the velocity of the sprayed surface within the given range affects neither the porosity nor the microhardness of the coating (causes some increase in the microhardness of the surface layer of the base material) and decreases its roughness, but also decreases the bond strength (within acceptable limits) and the utilization factor. Figures 2; references 4: all Russian.
[57-2415]

UDC 621.763:536.6:620.173:621.78

HEAT TREATMENT AND STRENGTH CHARACTERISTICS OF CORROSION- AND SCALE-RESISTANT EXTRUDED ALLOY FIBERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 81 pp 1-5
manuscript received 30 Jun 80

FEDORCHENKO, I. M., KOSTORNOV, A. G. and KIRICHENKO, O. V., Institute of Problems of Material Science, UkSSR Academy of Sciences

[Abstract] Corrosion- and scale-resistant fibers (12-24 μm in diameter) of three nickel alloys (Ni+ 20 wt.% Cr, Ni+ 20 wt.% Mo, Ni+ 15 wt.% Cr+ 15 wt.% Mo) have already been produced by a rather simple and efficient method involving extrusion of rayon thread filled with high dispersity metal powders and subsequent heat treatment. In a study of the heat treatment and the alloying process, rayon was found to decompose during sintering at 800-1200°C with most of its carbon becoming free to escape but some remaining bound as the binder. The amount of the latter must be controlled, to prevent carbide formation, which is done by preliminary thermal oxidation in air at 400-450°C for 0.5-1 hr. The tensile strength of the fiber product depends, furthermore, on the final sintering temperature. Sintering in a hydrogen atmosphere at 1200°C with subsequent soaking for 1 hr has produced fibers with a strength of 40-52 kgf/mm^2. Figures 3; references 4: all Russian.
[57-2415]

UDC 621.762

MAGNESIUM DIBORIDE AND ITS USE IN REACTIONS FOR SYNTHESIZING CUBIC BORON NITRIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 80 pp 77-79
manuscript received after revision 1 Jun 80

SEREBRYAKOVA, T. I., PONOMARENKO, V. A., KARASEV, A. I., SHEMANIN, V. I. and MAREK, E. V., Institute of Problems of Material Science, UkSSR Academy of Sciences

[Abstract] Transformation of hexagonal boron nitride (α-BN) to cubic boron nitride (β-BN) for use as an abrasive powder for knife-edge cutting tools occurs at temperatures above 1500°C and under pressures above $40 \cdot 10^8$ N/m^2, in the presence of catalysts such as magnesium nitride (Mg_3N_2) or metallic magnesium. Earlier studies have already established that this transformation is thermodynamically less probable in the pseudo-binary Mg-BN system than with MgB_2, which becomes thermally unstable at 800°C and releases metallic magnesium with an attendant formation of higher borides (MgB_4, MgB_6, MgB_{12}). Those borides become thermally unstable at successively higher temperatures. In this study magnesium diboride was found to dissolve up to 98% in many organic and inorganic acids as well as alkalis and NH_4Cl of various concentrations, at both room

temperature and the boiling point of the given solvent. It was also established that the yield of Elbor-P (β-BN) powder production is about 50% higher and the cutting characteristics of Elbor-P tools are better with MgB_2 than with Mg_3N_2 as catalyst. References 6: 4 Russian, 2 Western.
[61-2415]

UDC 531.755

DETERMINATION OF THE DENSITY OF POWDER, POROUS, AND FIBER MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 80 pp 53-37 manuscript received after revision 1 Jun 80

CHERNOV, R. V. and ANDRIYKO, A. A., Institute of General and Inorganic Chemistry, UkSSR Academy of Sciences

[Abstract] The manometric method of determining the density of materials with a large specific surface is analyzed, this method being based on a simple relation between the pressure readings of a mercury manometer and the volume of the free gaseous space minus the volume of the solid phase with an increment of the gas volume due to isothermal expansion. Both the sensitivity and the accuracy of this method are estimated theoretically, whereupon a new instrument is proposed with which the error of density readings may be reduced toward its practically feasible lower limit of 0.2%. The instrument consists of two working vessels connected through a tube with a valve, two measuring vessels connected through a tube with a valve, and an equalizing vessel between both sets in a thus formed 3-arm communicating system. This instrument has been tested on several porous, powder, and fiber materials such as sugar, paper, cottonwool, various inorganic salts, various carbides and nitrides, and some metals in powder form. Figures 2; references 2: 1 Russian, 1 German.
[61-2415]

UDC 621.762

DEPENDENCE OF THE SOUND-ABSORBING CHARACTERISTICS OF A FIBER-METAL MATERIAL ON THE GEOMETRICAL PARAMETERS OF ITS STRUCTURE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 80 pp 43-47 manuscript received after revision 1 Jun 80

ZORIN, V. A., IVANCHUK, A. A., KARPINOS, D. M., RUTKOVSKIY, A. Ye. and SMIRNOV, V.G., Institute of Problems of Material Science, UkSSR Academy of Sciences

[Abstract] The acoustic characteristics of sound-absorbing meshes made of metal fibers with an air cavity were studied over the 200-6300 Hz frequency range at sound pressures of 110 and 145 dB. The specimens were 2 mm thick and

32 or 102 mm in diameter, with the mesh porosity varied from 34 to 79%. The active component of the acoustic impedance was found to decrease with increasing mesh porosity, a porosity of 55-60% yielding the maximum absorption coefficient with the active component of the acoustic impedance approximately equal to the characteristic impedance of air (the imaginary component of the acoustic impedance equal to zero). The active component of the acoustic impedance and the absorption coefficient were also found to depend on the fiber diameter, at a given fiber porosity of 70%, the former decreasing and the latter increasing as fibers 150 μm in diameter were replaced with fibers 30 μm in diameter. Increasing the material porosity further increased the absorption coefficient. Experiments with "glad'" ("flat stitch") and "lastik" ("lasting wool") interlacing of 65 μm fibers revealed that increasing the number of interlaced fibers will increase the absorption coefficient, especially at lower porosity levels corresponding to an active component of the acoustic impedance larger than the characteristic impedance of air. Figures 5; references 5: 4 Russian, 1 Western.
[61-2415]

UDC 621.762

STUDY OF THERMAL PROCESSES DURING HOT HYDROSTATIC PRESSING OF PRODUCTS MADE OF POWDERS OF REFRACTORY NICKEL ALLOYS. PART II.

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, Oct 80 pp 25-28 manuscript received after revision 1 Mar 80

STAROVOYTENKO, Ye. I., GARIBOV, G. S., KOSTYUKOV, V. I., KRATT, Ye. P. and MOLCHANOV, I. V., All-Union Institute of Light Alloys

[Abstract] The major task involved in calculating the total duration of heating of a block used for hot hydrostatic pressing of products made of nickel alloy is that of calculating the process of equalization of temperature through the volume of the powder. The mean integral temperature of the powder can be used as a quantitative measure of its thermal state. Equations are presented for calculation of the change in surface temperature of a block during the initial period of heating, as well as the change in mean integral temperature within the volume of the powder in capsules of various shapes. The equation system presented can be used to calculate the heating time of a block if the rate of temperature rise on the wall of the capsule containing the block and the effective coefficients of temperature conductivity of the powder are known. Using the method outlined, the necessary heating time has been calculated for blocks with capsules of complex geometric shape and various sizes filled with EP741P refractory nickel alloy. The total duration of heating of the block in the furnace to the desired temperature of 1200$\pm$10°C varied from 11 to 24 hours, depending on the mass of the capsules. Estimation of the accuracy of calculations performed by the method suggested shows the maximum error is not over 10-12%. Testing of the mechanical properties of disks pressed with heating calculated by the equations presented confirms the correctness of the equations and the method. Figures 2; references 5: all Russian.
[45-6508]

UDC 621.762

PROPERTIES OF TITANIUM CARBONITRIDE-STEEL MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1, Jan 81 pp 24-26
manuscript received after revision 1 Mar 80

KIPARISOV, S. S., NARVA, V. K. and VA IL'YEVA, O. D., Moscow Institute of Steels and Alloys

[Abstract] The greatest improvement in the properties of hard alloys can be achieved by increasing the ductility of the hard component while retaining high hardness. One possible means is the use of transition metal carbonitrides as the hard component. Steel was alloyed with nickel, chromium and molybdenum as follows (mass %): Ni - 0.5-5; Cr - 2-10; Mo - 0.5-3; C - 0.2-1; Fe - remainder. Analysis of contact wetting angles indicated good wettability of titanium carbonitride. The conditions of production of a nonporous sintered material based on titanium carbonitride with the steel binder used were determined by methods of experimental planning. The optimal composition of the material as well as optimal production conditions were determined. The initial materials were mixed in a ball mill in an alcohol medium for 1 to 3 days. The mixture was then dried at 80-90°C, separated from the balls and screened. It was then pressed at 2 t/cm^2, sintered in hydrogen at 700-800°C, then sintered in a vacuum and a current of nitrogen at 1450-1500°C. The residual porosity of the vacuum-sintered specimens was 5%. Sintering in a carbon-tube resistance furnace in a current of nitrogen produced nonporous specimens. Metallographic study of the structure of the materials produced revealed no free graphite inclusions in any specimens. The strength characteristics and impact toughness of the material are found to depend greatly on the content of steel binder. The strength properties of alloys based on $TiC_{0.5}N_{0.5}$ are better than alloys based on $TiC_{0.8}N_{0.2}$. Figures 2; references 3: all Russian.
[43-6508]

UDC 666.593

HOT PRESSED CERAMIC BASED ON BORON NITRIDE AND SILICON DIOXIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1, Jan 81 pp 31-34
manuscript received after revision 30 Aug 80

USKOVA, L. B., TRIPOLITOV, A. I. and TSAPUK, A. K., Obninsk

[Abstract] Hot pressing of composite materials based on boron nitride and amorphous silicon dioxide was performed in a vacuum installation with induction heating. The pressing was done in graphite press molds at 1500-1800°C, 140-200 kg/cm^2. Specimens 60 mm in diameter and 65 mm high could be produced in the installation. The influence of temperature, pressure and holding time on the process of compacting and the properties of the ceramic produced was

studied. The hot-pressed ceramic produced is a mixture of silicon glass and BN crystals with a slight content of B_2O_3; specimens made of hexagonal boron nitride and silicon dioxide have low strength. Ceramic produced from turbostratic boron nitride and silicon dioxide has twice the bending strength of ceramic produced from hexagonal BN powder. This may result from the activity of the turbostratic boron nitride and the stronger bond of silicon dioxide with the boron nitride particles due to better wettability of the boron nitride resulting from the higher concentration of B_2O_3 in the initial material. Thermal erosion testing caused rapid melting of the small silicon dioxide grains, forming a pootective film which was quite tough and protected the boron nitride from oxidation. Figures 4; references 6: all Russian.
[43-6508]

UDC 621.762

CHANGES IN THE STRUCTURAL STATE AND MECHANICAL PROPERTIES OF POLYCRYSTALS BASED ON SUPERHARD MODIFICATIONS OF BORON NITRIDE DURING HEAT TREATMENT

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1, Jan 81 pp 53-61
manuscript received 7 Apr 80

GRIGOR'YEV, O. N., DZHAMAROV, S. S., TREFILOV, V. I. and SHATOKHIN, A. M.,
Institute of Problems of Material Science, Ukrainian Academy of Sciences

[Abstract] A study was made of the influence of thermal cycling on the structural characteristics (phase relationships, level of macrostresses, diffraction line width) and mechanical properties (hardness H_B, rupture stress σ_r and fracture toughness K_c) of boron nitride. The studies were performed on sintered BN obtained by the technology of manufacture of hexanite-R with BN_w [wurzite] contents of 0 to 100% (remainder BN_s [sphalerite]). The sintered specimens were heat treated under a vacuum in niobium foil envelopes. The structure of the specimens was studied by x-ray diffraction. Mechanical testing was performed by local loading using both pyramidal and spherical tips. The two-phase material was found to have a high level of both macrostresses and microstresses, resulting from the nature of the brittle fracture and the mechanical properties of the material. Processes of microscopic crack growth initiated by internal stresses when external loads are applied facilitate stress relaxation at the tips of propagating cracks, resulting in the high fracture toughness of the material. Heat treatment causes relaxation of internal stresses, which results in a decrease in fracture toughness to the level characteristic for single-phase unstressed sintered specimens. Figures 6; references 18: 13 Russian, 5 Western.
[43-6508]

UDC 21.762.5:537.311

CONDUCTIVITY OF POWDER ZrN-Al_2O_3, Mo-Al_2O_3 AND ZrN-Mo COMPOSITE MATERIAL

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, Oct 80 pp 56-60
manuscript received 26 Jan 1980

YEGOROV, F. F., Institute of Problems of Material Science, UkSSR Academy of Sciences

[Abstract] A study was made of the conductivity of binary composites with various volumetric contents of the components, as well as pure ZrN and Mo sintered in pure argon and nitrogen. The temperature variation of specific conductivity was determined in a special vacuum installation. The measurements were performed on cylindrical powder specimens 8 mm in diameter and 12-15 mm in height. The conductivity decreases with an increase in the content of the nonconductive phase. If the content of the nonconductive phase is over 80% by volume, the conductivity of the composites is so slight that they can practically be considered dielectrics. After liquid-phase sintering at slightly above the melting point at which the liquid phase first appears, the experimental points of resistivity lie on the calculated curve generated by the equation $\frac{\lambda_{cm}}{\lambda} = \phi(\theta)$, where λ_{cm} and λ are the conductivity of the composite and of the conducting phase, and θ is the content of the nonconducting phase by volume. Isothermal holding or an increase in the Al_2O_3 content with no holding results in an increase in resistivity. Either of these factors causes an increase in the quantity of liquid phase which penetrates between the nitride particles and reduces the metallic contact. Significant overheating results in recrystallization of the nitride grains, increasing the metallic contact area and thus increasing conductivity. The resistivity of specimens in this system sintered in nitrogen is an order of magnitude higher than that of specimens sintered in argon, a result of the more intensive oxidation of the ZrN granules and the formation of a nonconducting zirconium dioxide coating on their surfaces. A limited solid solution apparently is also formed in the system where the ZrN content is 15 vol %. Figures 5; references 7: all Russian.
[45-6508]

UDC 621.746.58

BASIC TRENDS IN NON-FURNACE PROCESSING OF STEEL FOR MASSIVE APPLICATIONS

Moscow STAL' in Russian No 3, Mar 81 pp 35-38

SHNEYEROV, Ya. A., ANDREYEV, B. K., BIKELEVSHCHUK, V. A. and OGRYSKIN, Ye. M., Institute of Ferrous Metallurgy

[Abstract] A review is presented of some processes performed outside of furnaces designed to improve the effectiveness of utilization of metal in the national economy. The processes include addition of small quantities of vanadium, vanadium with nitrogen or niobium to increase strength and cold resistance of killed manganese steel; addition of small quantities of vanadium, aluminum and titanium in the production of carbon steel for thin sheets, production of welding wire by addition of small quantities of zirconium, REM, vanadium and titanium; reduction of the melting point of vanadium-nitrogen alloys and other alloys used for addition to steel. Treatment of steel in the ladle with lime-alumina slag can decrease the concentration of sulfur by 50-75% and the concentration of oxygen by 50%. Vacuum treatment in the ladle can remove up to 80% of the hydrogen and 60-80% of the oxygen from steel. The simplest method of treatment of steel outside the furnace to equalize the composition and temperature of the steel is to blow a neutral gas through the ladle, a process which can be organized in existing steel production shops. Blowing of argon and powdered microalloying additives of calcium through the ladle can remove larger percentages of sulfur and oxygen, leading to the production of nonmetallic inclusions in the form of globules and increasing the cold resistance and isotropicity of rolled products.
References 7: all Russian.
[72-6508]

UDC 669.157.4-194.669.112.227.1

EFFECT OF EXPLOSION TREATMENT ON THE TEMPERATURE RANGES AND THE VOLUME EFFECTS OF TRANSFORMATION OF AUSTENITIC HIGH-MANGANESE STEEL

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 6, 1981 pp 1372-1375
manuscript received 25 Mar 80

BEREZINA, N. M., KUDINOV, V. M., VASIL'YEV, V. G., PETUSHKOV, V. G. and KORNIYENKO, G. A., Institute of Electric Welding imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev

[Abstract] The effect of explosion treatment of grade G13L steel on the kinetics and the volume effects of its phase transformation was studied, of particular interest being the range of lowest stability. Ingots containing 14% Mn with 0.95% C, 0.35% Si, 0.036% P, and 0.019% S had been smelted in a laboratory high-frequency furnace, then austenitized from 1050°C with water cooling, and then cut into 3 x 3 x 50 mm specimens by the electric-spark process. After explosion treatment in a 3 x 50 mm plane with an obliquely incident shock wave, volume effects were measured with a Chevenard dilatometer, microstructure was examined under a Neofot-2 optical microscope, microhardness was measured with a Vickers tester, and the amount of magnetic phase was determined with an MFA-2 Akulov magnetometer. The specimens were also isothermally tempered at 600°C for 3 hr and at 700°C for 1 hr. Measurements after tempering revealed an increase of cementite precipitation and of the troostite formation, while explosion pretreatment had shifted the A_{c1} temperature downward. The article was presented by Academician B. Ye. Paton on 10 Mar 80. Figures 3; references 7: 6 Russian, 1 Western.
[59-2415]

UDC 669.14.018.8

NEW CORROSION RESISTANT STEEL, TYPE 16KhNKGMB-VI

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 80 pp 40-41

SHPITSBERG, A. L. and BORISOV, V. A.

[Abstract] Type 16KhNKGMB-VI (EP899-VI) steel (Author's Certificate No. 440076) is intended for the manufacture of elastic sensing elements for instruments, automatic control systems and other devices operating at -196 and +400°C. It is a dispersion-hardened and tempered steel which is subsequently aged. The chemical composition according to TU 14-1-2745-79 is: <0.05% C; ≤0.3% Si; ≤0.015% S; ≤0.01% P; 0.8-1.2% n; 15-16% Cr; 6.5-7.5% Ni; 0.5-1.0% Ti; 0.3-0.5% Al; 3.0-3.5% Co; 2.3-2.9% Mo; 0.3-0.5% Nb; ≤0.008% B and 0.05% Ce. In the hardened state the steel consists of 40-50% martinsite. The elastic and strength properties of the steel are improved after elimination of the particles of intermetallides $Ni_3(Ti, Al)$, Ni_3 (Mo, Ti), carbides $M_{23}C_6$, NbC and

the Laves phase $Fe_2(Mo, Nb)$ from the solid solution during aging. The steel has excellent relaxation resistance at 400°C. It has high corrosion resistance under various climatic conditions and is not inclined to stress corrosion or intercrystalline corrosion. Special galvanic or paint protective coatings are not required in most cases. References 2: both Russian.
[68-6508]

UDC 621.791.793

NEW STRUCTURAL STEELS NOT REQUIRING NORMALIZATION AFTER ELECTROSLAG WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 80 pp 44-46, 59
manuscript received 7 Feb 80, in final version 26 Jun 80

YEGOROVA, S. V., candidate of technical sciences, STERENBOGEN, Yu. A., doctor of technical sciences, YURCHISHIN, A. V., engineer, Ye. O. Paton Institute of Electric Welding, Ukrainian Academy of Sciences, VINOKUR, B. B., doctor of technical sciences, Institute of Casting Problems, Ukrainian Academy of Sciences, SKUDITSKIY, M. S., engineer, "Soyuzneftekhim" Production Union, BUBLIK, G. I., BRONSHTEYN, L. M., engineers, "Volgogradneftemash" Production Union, RUBENCHIK, Yu. I., doctor of technical sciences, and BEREZHNITSKIY, S. N., candidate of technical sciences, VNIIPTkhimnefteapparatury

[Abstract] Results are presented from the development and application of new thermally stable cold resistant high strength steels to replace type 12KhM steel. These steels can be joined by electric slag welding without subsequent normalization. The chemical compositions and mechanical properties of the 11 steels tested are presented. The optimal compositions are 10Kh2GM (1.71% Mn, 0.80% Cr, 0.15% Ni, 0.006% Ce) and 10KhG2MCh (2.10% Mn, 1.20% Cr, 0.15% Ni, 0.018% Ce), produced in 60 and 75 ton open hearth furnaces with normalization and tempering. Photographs are presented of experimental vessels made of these steels and assembled by electric slag welding without normalization. Vessels made of these steels can operate at temperatures from -40°C to 350-560°C. Figures 2; references 4: all Russian.
[71-6508]

UDC 669.112.228.1:548.53

RECRYSTALLIZATION OF FERRITE UPON DECARBURIZATION OF LOW-CARBON STEEL IN THE INTERCRITICAL TEMPERATURE INTERVAL

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 6, Nov-Dec 80 pp 174-179 manuscript received 25 Jan 79

MOVCHAN, V. I., GRUDEVA, N. A. and BUGAYETS, M. P., Dnepronetrovsk

[Abstract] A study was made of the influence of defect content of a ferrite matrix on the formation of columnar crystals upon decarburization of 08 kp steel (containing, nwt.%: 0.076 C, 0.035 Cr, 0.012 Al, 0.018 S, 0.006 P) in a current of moist hydrjogn at 800°C aver a period of 30 minutes. Decarburization annealing causes recrystallization of ferrite in specimens of cold-deformed sheet steel with high degrees of deformation (over 10%). In specimens with low degrees of compacting, recrystallization does not occur. Specimens deformed to over 10% have low crystalline structure defect density in the core. The observations performed confirm that the motive force of the growth of large columnar crystals is an increased content of defects in the structure of the ferrite core of specimens, particularly increased dislocation density in specimens with little compaction. Figures 4; references 6: all Russian.
[50-6508]

UDC 548-162:539.3

INFLUENCE OF IMPURITIES ON ELECTRODIFFUSION FRACTURE OF THIN METAL FILMS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 1, Jan-Feb 81 pp 234-239 manuscript received 27 Feb 79

KOLESHKO, V. M. and BELITSKIY, V. F., Minsk

[Abstract] A model of the interaction of impurities with defects in the crystalline structure of a thin film is used to explain their retarding effect on electrodiffusion in thin films of metals, and to formulate a criterion for selection of an alloying component to slow electrodiffusion in thin film specimens. The analysis of the influence of impurities on the electrodiffusion of the matrix is based on distortions in the crystalline lattice around dissolved atoms. Concentrating on the grain boundaries, impurities change their free surface energy. The decrease in free energy of grain boundaries may result from improvement of the structure of the film due to the introduction of impurities or due to the development of a preferential orientation of the grains. In addition to this elastic interaction of impurity atoms with defects in the crystalline lattice, chemical and electrical interactions occur. The presence of impurity atoms on defects in the structure hinders the accumulation of vacancies on these defects which in turn causes an increase in the activation energy of formation of cavities. The most effeftive impurity for retarding electrodiffusion in thin metal films is one which differs in atomic radius from the atoms of the matrix, has little solubility in the matrix in the solid state and crystallizes in a crystalline lattice which differs from the lattice of the matrix. This theoretical conclusion was confirmed experimentally in thin films of aluminum with slight rare earth metal impurities. Figures 2; references 13: 8 Russian, 5 Western. [51-6508]

STUDY OF THE PROCESS OF FORMATION OF SURFACE LAYERS OF VT-9 TITANIUM ALLOY AFTER ELECTRIC-SPARK ALLOYING

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 4 (94), Jul-Aug 80 pp 28-31

VERKHOTUROV, A. D., TIMOFEYEVA, I. I., ROGOZINSKAYA, A. A. and POTERYA, Ya. D., Kiev

[Abstract] A stytematic study was made of the phase composition of the surface alloyed layers of VT-9 titanium alloy after electric-spark alloying with nickel, aluminum and NiAl. After electric-spark alloying, metallographic, durometric, microscopic x-ray and x-ray diffraction analyses of the surface layers were performed, as well as layer-by-layer x-ray phase analysis after successive removal from the surface of the specimens of layers 20-50 μm thick by means of diamond paste. It was found that the surface layers form as the result of the interaction of the material of the anode and the cathode and the interaction of the anode and the cathode with the medium between electrodes, forming oxides and nitrides, as well as diffusion saturation of the material of the base with the alloying elements. Figures 2; references 4: all Russian.
[49-6508]

UDC 620.171.3

EFFECT OF CYCLICAL LOAD HISTORY ON THE MECHANICAL CHARACTERISTICS OF THE VT3-1 AND VT22 ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 1, Jan 81 pp 82-85 manuscript received 13 May 80

YEREMIN, Yu. A., KLEBANOV, Ye. M., KOKOREV, I. A. and FEDOSEYEV, A. K., Kuybyshev

[Abstract] Results are presented from an experimental study of the influence of preliminary cyclical loading and creep on the deformation curve during subsequent static tensile loading of the VT3-1 and VT22 titanium alloys at 25°C. Preliminary cyclical loading is found to lead at first to an increase in strength characteristics; the greatest hardening occurs in the first cycles. The maximum

increase in yield point is on the order of 10%, of ultimate strength - 4% for VT22, 13.5% for both characteristics for VT3-1. Further increases in the number of cycles of preliminary loading cause the strength and yield point to decrease. The ductility of most specimens increases with an increasing number of preliminary loading cycles. The residual deformation accumulated in cyclical extension of these two materials is essentially creep. Figures 6; references 3: all Russian.
[47-6508]

UDC 669.295-158:620.17

INFLUENCE OF HYDROGEN ON THE MECHANICAL PROPERTIES OF α-TITANIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 1, Jan-Feb 81 pp 169-173 manuscript received 31 Oct 78

BUKHANOVA, A. A., GUSEVA, L. N. and EGIZ, I. V., Moscow

[Abstract] A study is made of the influence of various concentrations of hydrogen on the mechanical properties of iodide titanium. Mechanical testing of alloys of titanium with hydrogen in various concentrations demonstrates that differences in the morphology of the hydrides produced upon annealing and hardening significantly influence the strength and particularly the ductility properties of these alloys. In the annealed state, the variation of mechanical properties with hydrogen content is monotonous. However, the morphology of the hydrides in alloys of various compositions was not the same after annealing. In alloys with 4 and 7.5 at.% H the hydrides are very fine in structure. In alloys with 12 and 18 at.% H the structure is martensitic. The hardness of slowly cooled alloys of titanium with hydrogen up to 8 at.% increases slowly with increasing concentration, while after hardening the hardness is significantly increased. This characteristic depends on the texture of the specimen. Figures 3; references 2: 1 Russian, 1 Western.
[51-6508]

UDC 539.43:669.721.5:620.19

ESTIMATE OF THE PARAMETERS OF SUDDEN GROWTH OF A FATIGUE CRACK IN COMPRESSOR BLADES OF VT3-1 TITANIUM ALLOY

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 17, No 1, Jan-Feb 81 pp 71-74 manuscript received 21 Jan 80

BOTVINA, L. R., LIMAR', L. V. and LOGOVIKOV, V. S., Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences, Moscow

[Abstract] An attempt is made to establish the relationship between changes in the parameters of sudden growth of cracks (crack depth and edge length) and the amplitude of cyclical loading. Fatigue tests were performed on compressor blades

of VT3-1 titanium alloy with equiaxial microstructure. Crack edge lengths were measured on fracture photographs. The variation in crack depth and edge length as a function of cyclical loading amplitude can be used to calculate the stress levels leading to fatigue failure of the material. The stress causing generation and subsequent growth of fatigue cracks on a blade was calculated. The relationship between parameters of sudden growth of a fatigue crack under operating conditions follows the same regularities as on the test stand. Figures 3; references 5: 3 Russian, 2 Western.
[88-6508]

UDC 669.295.5:539.376

CREEP OF OT4 TITANIUM ALLOY WITH A COARSE-GRAIN STRUCTURE

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 80 pp 95-97 manuscript received 13 Nov 78

PESHKOV, V. V., RODIONOV, V. N. and PODOPRIKHIN, M. N., Voronezh Polytechnical Institute

[Abstract] The results are presented from investigating the high-temperature deformation of OT4 alloy with an equaxial lamellar structure in the 800-950°C range at stresses of 5.89-19.2 mN/m^2. The coarse-grain structure was obtained by heating for 20 minutes above 1000°C, followed by air or furnace cooling. Investigation of the temperature function of steady-state creep in the alloy showed that in the 800-930° range and at a stress of 12.6 mN/m^2 the apparent creep activation energy was independent of the beta-grain internal structure and amounted to 397.75 kJ/mole. Metallographic analysis indicated that there were traces of deep slip in individual grains and these slip traces were the result of the movement and interaction of dislocations which in turn result in deformation of the structure. Figures 3; references 6: all Russian.
[55-6368]

UDC 669.017

EFFECT OF IMPURITIES ON THE HARDNESS OF TITANIUM

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 5, Sep-Oct 80 pp 64-68 manuscript received 23 Feb 79

LISKOVICH, V. A., GONCHAR, V. Ya., BAUM, V. S., KONDUS, A. A. and BREYEV, N. P., All-Union Scientific-Research and Design Institute for Titanium

[Abstract] The effect of substitutional (iron, chromium and nickel) and interstitial (oxygen, nitrogen, carbon and hydrogen) impurities on the hardness of titanium was studied by experimental and statistical methods. It was established

that each of the substitutional elements increases the hardness of titanium by 0.4-0.5 Bhn units per 0.01% increase in element content. It was shown experimentally that oxygen increases titanium hardness. At contents up to 0.10% this increase amounts to 6 Bhn units per 0.01% oxygen. Statistically the effect of nitrogen on hardness up to a content of 0.15% was 5 Bhn per 0.01% nitrogen, and experimentally--0.02 to 0.35% (2-2.7 Bhn units per 0.01%). The effect of carbon on titanium hardness was found to be 3.9-6.7 Bhn units per 0.01% carbon in the 0.02-0.07% range. Hydrogen increases hardness by 0.92 Bhn units per 0.01% hydrogen in the hange of 0.007-0.010 H. The effect of hydrogen on titanium hardness was studied under the leadership of B. A. Kolachev. The following persons participated in this work: L. I. Kremen, N. O. Brant, M. F. Fedorov, Ye. I. Zobov, A. F. Zhevnovatnyy, I. S. Gridin, V. V. Zhurov and V. S. Obykhvostov. References 6: 4 Russian, 2 Western.
[55-6368]

UDC 669.295.681.3

CORROSIVE LIQUID DISPENSER IN THE PRODUCTION OF SPONGE TITANIUM

Moscow TSVETNYYE METALLY in Russian No 10, Oct 80 pp 97-100

ZBIRNYY, V. D., KUKUY, A. S. and ZEL'MANOV, I. N.

[Abstract] A dispenser of titanium tetrachloride with a dispensing error of not exceeding $\pm 1\%$ has been developed with a maximum productivity of 700 kg/hr at a working pressure of 0.5-1.8 kgf/cm^2. Tests conducted on this new unit on a group of reduction units showed that automatic dispensing stabilized the reduction process and improved the quantitative and qualitative indices of the produced sponge titanium. Additional technical specifications are given along with a structure diagram and picture of the dispensing unit. Figures 3; references 4: all Russian.
[56-6368]

UDC 620.17:620.18:669.295:621.777

RELATION BETWEEN THE STRUCTURE AND THE MECHANICAL PROPERTIES OF VT9 TITANIUM ALLOY AFTER SUPERPLASTIC DEFORMATION

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, Mar 81 pp 27-31

KAYBYSHEV, O. A., SALISHCHEV, G. A. and LUTFULLIN, R. Ya., Ufa Aviation Institute

[Abstract] Heat treatment of hot-rol[illegible]orged rods of VT9 titanium alloy at 950-97°C, below the polymorphous tr[illegible]nation temperature, with subsequent cooling to and aging at 530°C for 6 hr pro[illegible]ced a fine-grain globular microstructure

in rods 18 mm in diameter and a disperse lamellar microstructure in rods 32 mm in diameter. Deformation to a 75% strain at rates from a low $2.5 \cdot 10^{-4}$ s^{-1} to the optimum for each case, $3.1 \cdot 10^{-3}$ and $1.2 \cdot 10^{-3}$ s^{-1} respectively, into the superplasticity range produced some increase in strength and no significant change in plasticity. Additional heat treatment at 500°C for 200 hr of the rods with a disperse lamellar microstructure or deformation of both types at rates higher than optimum increased the strength only slightly but lowered the plasticity appreciably. These results, based on metallographic and x-ray diffraction analysis as well as mechanical testing, confirm that it is feasible to replace the annealing operation with superplastic deformation. Figures 1; references 9: 8 Russian, 1 Western.
[66-2415]

UDC 539.377:620.178.3

EFFECT OF CRYOGENIC COOLING ON THE STRAIN AND FRACTURE ANOMALIES OF TITANIUM ALLOYS IN THE SHORT-CYCLE RANGE

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 80 pp 184-190 manuscript received 21 Aug 78

STRIZHALO, V. A. and ZINCHENKO, A. I., Kiev

[Abstract] The short-cycle fatigue strength as well as the static mechanical characteristics of the VT1-0, AT2-2, VT5-1 and VT6S titanium alloys were measured at -196 and -269°C, in liquid nitrogen and in liquid helium respectively, and compared with their corresponding characteristics at 20°C in air. The fatigue strength with the static strength were found to increase and the plasticity was found to decrease with decreasing temperature in each case. The tests also revealed an intermittent and discrete yield under active load at low temperatures, its density of occurrence decreasing and the magnitude of plastic-strain jumps increasing with higher strength and with higher alloy content. Accordingly, the number of yielding events prior to fracture decreased from 100 in VT1-0 (technical-grade α-titanium) to 10 in AT2-2 (pseudo α-phase with 4.3% alloy content) to 5 in VT5-1 (α-phase with 7.5% alloy content) to 1-2 in VT6S ($\alpha+\beta$-phase with 9.7% alloy content). Each yielding event in a specimen was, moreover, accompanied by a temperature jump. The results indicate that particularly at -269°C the dislocation mechanisms of plastic deformation and, therefore, adiabatic deformation are suppressed, with fracture occurring due to fatigue cracks initiated by shear and propagating normally to the direction of the load. Figures 7; references 11: all Russian.
[60-2415]

UDC 669.295:539.375

STUDY OF THE NATURE OF THERMAL BRITTLENESS OF LOW-ALLOY α-ALLOYS OF TITANIUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 50, No 6, Dec 80 pp 1218-1225 manuscript received 25 Jul 79

NESTEROVA, Ye. V., RYBIN, V. V., USHKOV, S. S. and KOLODKINA, G. I.

[Abstract] The nature of the effect of embrittlement of low-alloy α-alloys of titanium was studied using technically pure titanium plus a model alloy containing 2% Al and 1,5% Zr. After annealing, bars were tempered for 500 hours at 100-700°C, then specimens were cut for impact bending testing and also for studies by the methods of optical metallography, scanning and transmission electron microscopy. It was found that beginning at a temperature of about 250°C, 500 hour tempering actually increases the brittleness of both the alloy and technically pure titanium. Their impact toughness decreases with increasing T, reaches a minimum at a temperature of about 500°C, then once more increases, the embrittlement disappearing completely at about 700°C. The microhardness of both technically pure titanium and the alloy shows a tendency to decrease after tempering at T-400-600°C. The combination of observations indicates that embrittlement does not result from precipitation of finely dispersed grains, but rather from qualitatively different processes developing on the grain boundaries. A careful study by optimal metallography and electron microscopy indicates that thermal brittleness also results from the presence of impurities, being caused by the redistribution of the impurity atoms between the body of the grain and the grain boundaries, the formation of impurity segregations and, as a result, precipitation of finely dispersed phase on the grain boundaries. Figures 4; references 15: 11 Russian, 4 Western.
[52-6508]

UDC 669.295:620.1

GRAIN ORIENTATION AND SOME PROPERTIES OF ELECTROLYTICALLY REFINED HIGH-PURITY AND HIGH-PLASTICITY TITANIUM

Moscow TSVETNYYE METALLY in Russian No 3, Mar 81 pp 73-74

ADAMESKU, R. A., ALSAGAROV, A. A., GEL'D, P. V. and KOYGUSHSKIY, N. N.

[Abstract] A study was made of titanium produced by electrolytical refinement of low-grade sponge. Ingots of various degrees of purity were examined crystallographically and found to differ much in grain size. The grain orientation was measured with a DRON-0,5 diffractometer in copper-line radiation, using a scintillation counter and differential discrimination. Hardness served as the measure of purity, increasing from 750 to 1910 MPa HV with the oxygen content increasing from 0,040 to 0,160 wt.%. Mechanical properties such as strength, yield point, percent reduction and percent elongation of longitudinally cut and

radially cut specimens improved with hardness, without an appreciable anisotropy; electrical resistivity also increased with higher oxygen content and increased hardness. Figures 1; references 3: all Russian.
[81-2415]

UDC 621.791:621.78:620.17:669.71

INFLUENCE OF HEAT TREATMENT ON THE STRESS STATE AND MECHANICAL PROPERTIES OF JOINTS IN 01420 ALUMINUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 80 pp 70-71

CHAYUN, A. G., engineer

[Abstract] A study is made of the influence of hardening and artificial aging on the stress state and mechanical properties of welded joints in 01420 alloy. Argon-arc welding with Sv-AMg63 wire 2 mm in diameter with asymmetrical sinusoidal current was used to join plates 500 x 200 x 3 mm under the following conditions: $I_{w.w}$=95-100 A, $I_{w.sp}$=45-50 A, U_d=12-13 V, v_w=18 m/hr, C_{as}=0.7. It was found that the greatest tensile strengths (130-150 MPa) were produced in seams not heat treated after welding. In joints in metal artificially aged before welding the zone of plastic deformation is narrower than in hardened metal. Artificial aging after welding almost halves the level of residual stresses in the plane of the seam. The zone of influence of tensile stresses is simultaneously reduced. Hardening in air with subsequent artificial aging of welded joints restores the mechanical properties of the metal in the zone of thermal influence and results in complete relaxation of residual stresses. The ultimate strength of weld joints increases to about 400 MPa, 90-95% of the strength of the base metal. Figures 1; references: 1 Russian.
[71-6508]

UDC 621.791.762.5

BUTT WELDING BY FUSION OF STRIPS OF TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 81 pp 12-14

KABANOV, N. S., candidate of technical sciences, MOKEICHEV, V. G., candidate of technical sciences, MUKHIN, G. G., candidate of technical sciences, and MAKUSHEVA, N. A., engineer, VNIIMETMASH

[Abstract] An analysis of the conditions necessary for butt welding of titanium alloys by melting in argon indicates that welding of titanium alloy strips requires intensive melting and compression with low values of Δk. The structure

of joints produced in butt welding of titanium is formed under the influence of heating above the temperature of polymorphous conversion, hot deformation of the β solution and martensitic conversion during rapid cooling. Plates of martensite were not seen in a narrow seam strip 0.02 mm wide with recrystallized small grains. Next to this zone is a zone of metal heated to less than the $\alpha + \beta \rightleftarrows \beta$ conversion point with a two-phase area of α- and β-solutions and a mixture of the $\alpha + \alpha'$ phases. In the neighboring zone of metal with residual β phase an area with a width close to Δk=1 mm of grain growth is noted, the dimensions of the grains being determined by the size of the plates of ' phase at the beginning of cooling. The narrow zone of heating, and rapid me'ting of the melt allow a great decrease in the content of oxygen and resultant hardening of the metal in the seam, so that the strength and ductility of joints of VT1-0 and OT4-1 alloys after welding in VT14 and heat treatment are identical to these characteristics in the initial metal. Figures 3; references 9: all Russian.
[75-6508]

UDC 621.791.4:539.378.3

INTERACTION OF CONTACT SURFACES DURING DIFFUSION WELDING OF TITANIUM ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 81 pp 6-7

GRIGOR'YEVSKIY, V. I., candidate of technical sciences, KARAKOZOV, E. S., doctor of technical sciences, IL'IN, A. M., candidate of technical sciences, RODIONOV, V.N. and PETRUCHUK, L. N., engineers

[Abstract] The purpose of this work was to determine the specifics of the contact interaction of surfaces and the technological conditions of the formation of a strong joint during diffusion welding of titanium alloys with various loading schemes. Studies were performed on specimens imitating the microscopic projections of welded surfaces at a welding temperature of 700-1000°C and a pressure of 0.2-1.0 kgf/mm^2 after preliminary mechanical polishing to Rz=0.1 μm. Welding was performed under vacuum with additional evacuation of specimens by the use of a getter screen of titanium foil in an installation with radiation heating. The results of the studies show that the minimum welding temperature for OT4 titanium alloy depends primarily on the condition of the interacting surfaces, the environment and the nature of plastic deformation on the contact point. The activation energy is about 50 kca /mo , indicating that the process of joint formation is controlled by the removal of barrier oxide films from the surface before the moment of contact interaction. Production of a defect-free joint by diffusion welding with constant compression requires that the temperature be raised to above the $\alpha+\beta \rightleftarrows \beta$ conversion point of the titanium alloy. Figures 7; references 4: 3 Russian, 1 Western.
[75-6508]

UDC 621.791.76:621.7.044.2

QUALITY OF STAINLESS STEEL - TITANIUM BIMETAL STRIPS PRODUCED BY EXPLOSION WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, Feb 81 pp 53-56 manuscript received 1 Aug 80, after final revision 21 Oct 80

KUDINOV, V. M., doctor of technical sciences, KOROTEYEV, A. Ya., candidate of technical sciences, GORDAN', G. N., candidate of technical sciences, and LOKSHINA, Ye. Ya., engineer, Institute of Electric Welding imeni Ye. O. Paton, UkSSR Academy of Sciences

[Abstract] A technology has been developed for producing corrosion resistant bimetal strips of stainless steel and titanium by explosion welding with subsequent heat treatment for up to 1 hr followed by air cooling. Experimental strips of 10Kh17N13N3T and OKh23N28M3D3T steels up to 40 mm thick were plated with layers of OT4 titanium or VT1-1 titanium alloy up to 16 mm thick and strips of OT4 titanium up to 40 mm thick were plated with layers of 12Kh18N10T steel up to 16 mm thick, in each case after a preliminary strike with a 3-mm-thick layer of VT1-1 titanium alloy, and then heat treated at 300-800°C. The maximum bond strength of 250-350 N/m^2 can be attained with a titanium plate on steel not thicker than 8 mm and with a 3-4-mm-thick steel plate on titanium. The optimum detonation is with a wave velocity of 2500 or 2600-2700 m/sec, respectively, the initial distance between both layers before impact being equal to the thickness of the plate, and the optimum ratio of charge distance to charge height 2.0-3.3 or 1.5-2.0, respectively. Such bimetal strips should not be heat treated above 500°C, to avoid diffusion of titanium into steel and of iron, nickel, chromium, and copper into titanium across the contact zone with a resulting decrease in the bond strength. Figures 5; references 4: all Russian. [63-2415]

UDC 621.791.4:539.378.3

TEXTURAL NONHOMOGENEITY WITHIN THE SEAM ZONE OF VT6 TITANIUM ALLOY DURING DIFFUSION WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, Feb 81 pp 30-31 manuscript received 10 Jun 80, after final revision 27 Oct 80

KARAKOZOV, E. S., doctor of technical sciences, TERNOVSKIY, A. P., candidate of technical sciences, TARLAVSKIY, V. E., candidate of technical sciences, and POTAPOV, A. I., engineer, Moscow Evening Institute of Metallurgy, PERLOVICH, Yu. A., candidate of technical sciences, and ISAYENKOVA, M. G., engineer, Moscow Physico-Technical Institute

[Abstract] Metallographic examination of welding seams produced by diffusion welding with stimulated strain of VT6 titanium alloy at 960°C reveals no interface at almost any strain rate, while their toughness varies with the strain

rate and is maximum at approximately $2.5 \cdot 10^{-4}$ s^{-1}. An x-ray diffraction analysis of such welding seams was made, therefore, which would reveal the interface by a change in the crystallographic texture. Cylindrical specimens 10 mm in diameter of this fine-grain ($\alpha+\beta$)-phase alloy were diffusion welded at temperatures from 840 to 1080°C with strain rates from $2.5 \cdot 10^{-5}$ to $1 \cdot 10^{-2}$ s^{-1}, resulting in a 5% strain. Measurements were made with a DRON-1.5 x-ray diffractometer using a Cu K_α radioactive source. An analysis of the x-ray scattering patterns and the x-ray line spectra indicates that only seams produced at 960°C with a strain rate of $2.5 \cdot 10^{-4}$ s^{-1} are texturally homogeneous. At higher temperatures with an attendant lower level of strain hardening the $\alpha \rightarrow \beta$ transformation produces a nonuniform strain distribution and thus a textural nonhomogeneity with a lower toughness. At lower temperatuess or at lower strain rates, on the other hand, textural nonhomogeneity is a result of intensive slip along grain boundaries associated with superplasticity. Figures 3; references 4: all Russian.
[63-2415]

UDC 621.791.753.5

CHARACTERISTICS OF OXIDATION OF A METAL BY TITANIUM DIOXIDE DURING WELDING AND BEADING UNDER A FLUX

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, Feb 81 pp 22-26 manuscript received 17 Mar 80, after final revision 10 Jun 80

POTAPOV, N. N., candidate of technical sciences, and VOLOBUYEV, Yu. S., engineer, Scientific-Industrial Association: Central Scientific Research Institute of Machine Manufacturing Technology

[Abstract] A study was made to determine the metallurgical effects of replacing silicon dioxide with titanium dioxide in welding fluxes. A series of ceramic fluxes of the basic composition 55% CaF_2 +45% TiO_2 + 5% MgO, with varying amounts of CaF_2 replaced by ferrosilicon, was prepared and then used for multilayer beading with a 4-mm-diameter SV-08A welding rod. Another series of ceramic fluxes consisting of (75-45)% CaF_2 + (20-50)% TiO_2 + 5% MgO was prepared and then used for multilayer beading with 3-mm-diameter SV-08GS and SV-08Kh19N10G2B welding rods. The welding was done under constant conditions with a current of 500 A or reverse polarity at a voltage of 35-36 V, at a rate of 25 m/hr. The results obtained by processing the data of qualitative and quantitative chemical analysis of the beaded metal, also of data on the oxidation-reduction reactions in the welding pool as well as in the boundary layer of slag, and on the temperature dependence of the thermodynamic potentials of these reactions reveal that, as the TiO_2 content in the flux and the Si Content in the welding rod increase, the Ti content in the beaded metal increases together with the amount of oxide inclusions. While TiO_2 is reduced to metallic titanium as silicon is oxidixed, other alloying elements in the beaded metal with less chemical affinity to oxygen can also become oxidized, even during partial reduction of TiC_2 to TiO and Ti_2O_3. Accordingly, use of titanium oxide in these fluxes is not particularly advantageous. Figures 6; references 8: all Russian.
[63-2415]

SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS DESCRIBED

Moscow MOSKOVSKAYA PRAVDA in Russian 11 Jan 81 p 3

[Article by V. Melik-Nubarov: "When Metal Burns"]

[Text] A diamond can be cut only by a diamond and has a practically unlimited service life in industrial products. Today, just as thousands of years ago, it is unlikely that anybody will dispute this statement. The diamond has acquired the genuine value of a standard of hardness today, when industry more and more requires high-strength materials.

No diamond mines are capable of satisfying industry's requirements in cutting tools. For this reason techniques have been developed for producing synthetic diamonds, and powder metallurgy enterprises have been built, the products of which are equal to corundum in hardness. The search for ultrastrong synthetic materials is being conducted in many institutes throughout the world. But there occur instances where discoveries take place unexpectedly and not at all in that area where scientific research is being conducted.... Routine work was in progress at the laboratory of the USSR Academy of Sciences Institute of Chemical Physics -- the processes of combustion of various substances were being studied: does it burn fast, slow, how and under what conditions can it be ignited, what is the combustion product....? We must remind the reader that combustion is not a rapid oxidation reaction, as the chemists of the past viewed it, but any chemical process distinguished by short duration and the liberation of a large quantity of heat. Naturally fire occurs, but the combustion product will not necessarily be ashes.

Hundreds upon hundreds of experiments were conducted in order to gain practical confirmation of the theory of combustion developed by the institute's director, Academician N. N. Semenov, and to study the transformation of substances in flame. The purpose is to utilize the results of these tests in future research and in developing production technologies. They studied the combustion of gases, propellant powders, and explosives. They then proceeded to burn unusual substances and mixtures of such substances. There was additional work to do in this area: they were elucidating the conditions under which it is possible to ignite that which cannot burn in the normal definition of the term. These conditions proved to be most unexpected: in a vacuum and in an environment of ultrahigh gas pressures, under a press, under the effect of centrifugal force, and with electric current simultaneously passing through.... It was determined that practically everything burns, even metal and minerals. But this discovery led to

unexpected results. If test specimen components are heated at any one point up to 1000-1500 degrees, a flame flares up, a billow of fire "consumes" them within seconds, and as a result unusual synthetic products are produced. Combustion of mixtures of metal powders with carbon, boron, and silicon produces materials distinguished by extreme hardness, refractoriness, and resistance to wear. A new method of obtaining synthetic competitors to the diamond was found in such an unexpected manner.

The new method was called self-propagating high-temperature synthesis. It soon acquired unprecedented popularity. Patents have been issued on it in the world's most developed countries. In this country it is already in commercial use, using it in cutting tools, which contain no short-supply tungsten, as well as machinery parts which easily withstand ultrahigh pressures, temperatures and speeds, and powders for coatings which protect metals from corrosion and wear. At the very outset of practical application, this synthesis is already saving the state tens of millions of rubles. It does not require complex equipment and heavy electric power consumption. The new method is used to produce synthetic titanium carbide -- a highly valuable component of many refractory materials. Combustion products have been employed for the first time in the production of abrasive pastes, and these pastes compete successfully with diamond pastes, while in some operations they are superior to the "king of hardness."

In the section entitled "Development of Science and Acceleration of Technological Progress" of the CPSU Central Committee draft document for the 26th CPSU Congress, we read the following: "Develop and adopt highly efficient methods of increasing the strength properties, corrosion resistance, heat and cold resistance of metals and alloys... increase production of new structural materials, coatings and products...." These goals are pursued by a number of projects at the Institute of Chemical Physics. The self-propagating high-temperature synthesis technique can also be effectively utilized here.

New shops are already being designed and built at the most diversified enterprises in this country, where new, inexpensive, practical materials will be produced by this method. But no matter how rapidly its adoption proceeds, we are still at the threshold of an industrial revolution caused by this unexpected discovery.

This revolution is gradually being prepared by scientists. Do you know what pressure contact welding is? With enormous expenditures of electric power it is capable of welding together only certain metals, while the welded area does not exceed several square centimeters. But any large surfaces of refractory materials can be welded by the new technique. One can solidly unite graphite and molybdenum, for example, and the junction area is of no significance. The flame will pass along the boundary between the parts and weld them together. Within seconds one can produce a double-layer pipe for pumping acids and alkalis. It is necessary only to rotate a mold for casting such a pipe while the required components are burning in it. Centrifugal force pushes the heavy substance -- metal or hard cast alloy -- toward the exterior portion of the mold. The light substance, aluminum oxide, for example, which is not attacked by aggressive media, will end up at the interior wall.

This technique is presently being utilized in the laboratory to produce not only new materials but also finished products, firing components in a special compression mold. The still-hot combustion product is squeezed in the mold, and the item is ready.

Having introduced the reader to this new technology, I invite him to continue on, into an area very reminiscent of science fiction. If you think about it, however, there is little of the fantastic here. Why not build equipment into which charge is continuously fed, a mixture of the required components for producing some special synthetic substance by the new technique? A flame is burning inside the unit, igniting the powders of metals and non-metals as they are fed, the "jaws" of the compression mold actuate in a rhythmic manner, and finished products emerge, one after another, on a conveyer belt at the other end of the unit. It is interesting to note that this equipment will not even need power: the ignited charge will burn like firewood placed in a stove.

As they say, you haven't seen anything yet, for if other components are ignited in the same way -- hydrogen, oxygen and crushed ore, one can obtain a continuous flow of reduced iron and other metals which are produced by a great many metallurgical enterprises in this country. There will be no need for huge furnaces consuming large quantities of fuel. They will be supplanted by installations akin to continuous steel casting units, but much simpler and smaller. Things can also be set up so that in place of metal, ingots or finished products can come out of the unit -- we have an entire factory here.

Thought must also be given to the question of what to do with the huge amounts of heat released during synthesis, for the combustion temperature of metal, and nonmetal as well, runs to 4000 degrees, and this is above the melting point of many chemical elements. Since you and I have organized the process as continuous, let us also utilize the energy released during this process. We shall use it to heat water and heat a city, let us say. Or even better, we shall use it to generate electricity, so that our "open hearth furnace" will double as a power generating plant.

One senses a flaw, however, in this excursion into the future. No matter how much we fantasize, we are nevertheless unable to imagine all of the advantages of self-propagating high-temperature synthesis. Science and industry will very successfully accomplish this task. I was told this by Professor Aleksandr Grigor'yevich Merzhanov, director of the Institute of Chemical Physics laboratory. He told me in a matter-of-fact manner. His daily painstaking work in the laboratory has long since removed the aura of the fantastic from this new method. But we have yet to become accustomed to everything he knows about this method and its future potential.

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CSO: 1842/40

UTILIZATION OF SCRAP METAL

Moscow IZVESTIYA in Russian 18 Jan 81 p 2

[Article by IZVESTIYA correspondent G. Shcherbina, Chelyabinsk: "Two Approaches -- Two Results: Experience and Problems in Utilizing Scrap Metal"]

[Text] Each year -- this has already become a tradition -- the Chelyabinsk Vtorchermet Production Association holds a unique holiday celebration for schoolchildren. This was the case last year as well. One sunny day 2,000 trucks, accompanied by representatives of oblast Pioneer troops, delivered to the association's main facility thousands of tons of scrap metal collected by students. While the vehicles were being unloaded, association personnel acquainted their young friends with their complex operations, fed them dinner, and showed them interesting films in the auditorium. Later the Pioneers -- the best scrap metal collectors from 11 rayons in the oblast -- were taken by bus on an excursion to points of interest in the capital of the Southern Urals. A traditional Pioneer heat was then held at the Chelyabinsk Metallurgical Plant. It was held in Open Hearth Shop No 1 by the Komsomol-youth brigade of Lenin Komsomol Prize recipient V. Kondrateni. Here the children -- to the roar of the flame in the furnace and the glow of the bubbling metal during the pouring, saw the importance of their labor, which had seemed simply a lot of fun to many of them prior to this moment....

"The 10th Five-Year Plan was successful for us," stated association chief engineer V. Bessonov. "All shops performed in a stable manner and successfully achieved their plan targets. This was promoted to a significant degree by retooling of production and adoption of the advanced brigade form of organization of labor. Daily evaluation of performance quality was adopted in a number of shops."

Coordinated production and innovative search by each and every worker made it possible to procure above target more than 5,000 tons of scrap metal in 1980 alone. In 1979 the association was awarded for its achieved successes the Red Banner of the CPSU Central Committee, USSR Council of Ministers, AUCCTU and Komsomol Central Committee. Last year as well, based on performance results for the first three quarters, it was declared winner of the All-Union Socialist Competition among enterprises of its branch, and it fulfilled as early as September its five-year plan target pertaining to sales and output of commodity production.

I inquired at metallurgical enterprises whether they were satisfied with the job being done by the Vtorchermet Association. V. Skrypnik, scrap metal engineer at the Chelyabinsk Metallurgical Plant, gave the following reply: "We have no complaints about Vtorchermet. The very fact that we have a full supply of scrap metal

for the entire winter of 1980-1981 attests to the fine job being done by the association."

Other metallurgical workers made similar flattering comments. The Chelyabinsk Vtorchermet people, however, are not letting this praise go to their heads. The fact is that in spite of all their achievements, they still have many bottlenecks to correct in the new five-year plan. Association director L. Zhizmor, engineer-technician personnel, and the rank-and-file workers are well aware of these. The main concern is to improve the quality of the product delivered to the customers. It is the association's job to receive scrap, process it, and reduce it to the proper size. But the problem lies precisely here. There are various reasons for this.

Work is particularly impeded by the lack of smooth inflow of scrap metal from other republics and oblasts -- sources of almost half of total scrap metal procurement.

The association has no other means of pressuring suppliers than telegrams, letters, and "messengers." The USSR Ministry of Ferrous Metallurgy does not always utilize its power. The result is that sometimes a flood of scrap is coming in while at other times nothing is coming in at all: the powerful processing equipment is either standing idle or is working at maximum load. And of course quality suffers with these conditions. In addition, this causes rail flatcars to stand idle, cars which are in short supply.... There is also another reason for the shortage of rolling stock -- car underloading. Because enterprises lack equipment for primary baling of scrap, it is shipped to the Vtorchermet collection points light -- 33 to 50 percent below freight car load capacity.

The association is presently working on this problem. First of all, they are installing new equipment in shops located near large metal suppliers -- shears, hydraulic presses, etc; secondly, measures are being taken to improve record keeping on procured scrap -- special scales are being installed for weighing freight cars. But for the time being in many cases scrap metal is being weight-estimated by eye.

There are also other factors, however, which hinder better utilization of scrap metal. In particular, these include a lack of discipline on the part of those who should be promptly and precisely meeting scrap iron and steel delivery targets. For a number of years now, for example, the enterprises of Glavyuzhuralstroy, the local industry administration, the Chelyabenergo Combine, the Yuzhuralvtorsyr'ye Trust and others have been regularly failing to meet the target pertaining to delivering raw material for open hearth furnaces. Even such a leading enterprise as the Magnitogorsk Metallurgical Combine frequently fails to deliver scrap in a uniform manner. For example, it should be sending to Chelyabinsk worn-out ingot molds for processing to cupola furnace size, that is, for loading into furnaces. But the delivery schedule is frequently not met, with the result that Vtorchermet equipment stands idle.

Since we are speaking of Magnitka, we should mention the following. There exists between metallurgical enterprises a system of intra-branch deliveries of scrap metal. Unfortunately this arrangement is frequently honored in the breach. That same Chelyabinsk Metallurgical Plant, which has a scrap metal supply for the entire winter through the efforts of Vtorchermet, is short of rolling-mill carbon-steel

cutoff pieces for producing important grades of steel in electric furnaces. Delivery shortfalls on this raw material totaled 19,000 tons last year. Enterprises failing to deliver include the Magnitogorsk Metallurgical Combine, the Orsk-Khalilovo Combine and Zapsib. But the "record" is held by the Nizhniy Tagil Combine, which fell short by 15,000 tons of cutoff scrap. Therefore problems in the operations of the Chelyabinsk Metallurgical Plant which were observed last year also are on the conscience of metallurgical workers in other cities.

Common, garden-variety poor management by the officials of certain enterprises is a real hindrance to scrap iron and steel deliveries. At the Chelyabinsk Automated Machinery Shop (E. Ostanin, director), for example, each year more than 20,000 tons of waste metal is generated. As the people at Vtorchermet determined, however, at this plant they are constantly failing to adhere to the regulations on collecting, storing and shipping iron, steel, and alloy metal scrap. Different types and grades of this scrap are mixed in together, and metal scrap is scattered all over the plant grounds, which is subsequently buried under trash and dirt and lost forever. It is truly sad to see, for example, half-buried cast-iron machine tool beds dotting the ground around the motor transport shop. Alloy metal losses are also considerable. It has been calculated that losses in the last five years have been as follows at this plant due to poor management, in figures converted to alloying elements: tungsten -- 16.5 tons; molybdenum -- 4.7 tons; vanadium -- 3.1 tons; nickel -- 1.2 tons; cobalt -- 420 kilograms.

The CPSU Central Committee draft document for the 26th CPSU Congress contains the following: "Ensure fuller utilization and high-quality preparation of scrap iron and steel." Consequently the experience amassed in this area in the last five-year plan must be built upon and placed in the service of further boosting the economy. A cooperative effort is needed to accomplish this task -- by Vtorchermet workers, metallurgical workers, and all those whose job is to be concerned with boosting production of high-quality metal in this country.

3024
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SMALL SCRAP PROCESSING PLANTS IN BELORUSSIA

Minsk SOVETSKAYA BELORUSSIYA in Russian 16 Jan 81 p 2

[Article: "Such Plants Are Needed"]

[Text] The workers of our republic, just as throughout the country, are vigorously discussing the CPSU Central Committee draft document for the 26th CPSU Congress. Every day the mail brings letters containing responses, opinions, and suggestions. This is evidence of genuine worker participation in planning and management of the nation's economy.

Metallurgical engineer V. Dorofeyev suggested, in a note entitled "Are Such Plants Necessary?" (SOVETSKAYA BELORUSSIYA, 13 January 1981), deleting the following from the draft Principal Directions: "Build small-capacity metallurgical plants at locations where iron and steel scrap is generated...."

The editors receive reader responses in which the authors are totally in disagreement with V. Dorofeyev. Here, for example, is the opinoin of B. P. Shashkov, deputy director of the Belorussian Republic Vtorchermet Association: "I consider the provision contained in the CPSU Central Committee draft document to the 26th CPSU Congress on the need to build small-capacity metallurgical plants at locations where scrap metal is generated to be both timely and reasonable, because such enterprises will solve many acute and complex economic problems. First of all they will make it possible to reduce the enormous transport expenditures on counterflow hauling of metal and scrap; they will help more efficiently supply the enterprises of a given area with rolled stock; they will make it possible to eliminate equipment stoppages which sometimes occur due to a lack of raw materials.

"For example, we must ship out of Belorussia more than 1 million tons of scrap metal every year. We spend more than 6 million rubles just on one-way hauling. This ties up considerable rolling stock which could be utilized for hauling above-target output. In short, one cannot agree with V. Dorofeyev's suggestion. Processing metallurgical plants are needed, and as soon as possible."

And what do the republic Gosplan people think about this? O. N. Kechin, chief specialist of the Department of Planning and Coordination of Intersectorial Production Facilities of Belorussian SSR Gosplan, is of the opinion that a very acute and important question has been addressed.

"At one time," he stated, "we had to study this problem thoroughly and comprehensively. Therefore there is every reason to state that there is a need today, in this

country and this republic, for small-capacity metallurgical plants engaged in processing scrap metal. Of course such enterprises are a comparatively new thing, evoked by vital necessity, by concern for efficient development of production. Studies by influential scientists indicate that construction of such enterprises has become a worldwide trend. Approximately 300 such plants are operating very effectively in industrially developed countries, for example."

One cannot agree with many of the points made by the author of "Are Such Plants Necessary?", since he approached the problem somewhat speculatively, yielding to traditional and now obsolete views on the development of industry. In his reasoning and arguments V. Dorofeyev proceeds from a number of erroneous premises. In particular, he states that there is a shortage of scrap metal resources in this republic, discusses the converter technique of processing scrap, and the production capacities of foundry shops at machine building plants. But perhaps the most important thing is that the author incorrectly treats the very term "small-capacity metallurgical plants," denying that they have extensive potential for mechanization and automation of processes.

Let us look into this matter in greater detail, with figures and an analysis of contemporary trends. Iron and steel scrap resources are constantly growing. According to the figures of the All-Union Scientific Research and Design Institute for Processing of Scrap Iron and Steel, for example, scrap metal resources in our republic will reach a figure of more than 2 million tons by 1985. Present procurement volumes range from 1.2 to 1.4 million tons, that is, a growth increment equal to 600-800 thousand tons. If one considers the fact that only one third of procured raw materials is utilized by foundry operations of Belorussian SSR machine building plants (as much as production capacity permits), while the remainder must be shipped out of the republic to traditional processing locations -- plants in the Urals, Cherepovets, and the Southern Ukraine, the expediency of building such enterprises will become obvious. There is a guarantee of their continuous operations -- growth in scrap metal resources due to dynamic expansion of this republic's industry.

In addition, requirements in rolled stock of various sections, especially light and medium, are growing. Already today Belorussian enterprises consume approximately 2.8 million tons of rolled metal and 1.1 million tons of castings. And while castings are produced at foundry facilities of machine building plants, for the most part all rolled stock is hauled in from distant sources. This in turn creates difficulties in transporting both scrap and metal. According to studies by the USSR Gosplan Institute of Combined Transport Problems, for example, 10 to 15 years hence counterflow hauls of metal in the Belorussian SSR, the Baltic, and Ukraine, may double or triple, with freight traffic in these items possibly totaling 4-5 billion ton-kilometers. Naturally this will aggravate both transport problems and enterprise metal supply.

One must also consider the following aspects of the problem. Existing metallurgical plant production facilities, taking into account the increasing production of metal in converter shops and a decrease in the percentage share of open-hearth production, have become unable to process the increasing quantity of scrap metal. A conclusion suggests itself: these enterprises must be expanded, and new ones built. But should they be built in the traditional metallurgical centers? We believe that it is more efficient to build new small plants near the location of scrap metal collection and consumption of industry's "grain."

As regards plants which process scrap metal, here one must consider the following. They are called small in comparison with the metallurgical giants. In fact these are modern enterprises which pay for themselves rapidly. Their economic effectiveness is confirmed by calculations performed by the Design Institute of the USSR Ministry of Ferrous Metallurgy, which elaborates technical-economic substantiation for construction of steelmaking plants. In Belorussia, for example, plans call for building such a plant in Zhlobin. Its designed capacity is figured at production of half a million tons of rolled stock per year. The plant will employ a work force of approximately 3,300. Modern, advanced equipment will be installed, with total mechanization and automation of production. This will make it possible to achieve high labor productivity -- output per worker will comprise not less than 25,700 rubles.

Such a plant will pay for itself within approximately 7.3 years. It will make it possible to reduce transport expenditures on hauling 500,000 tons of scrap and 500,000 tons of rolled stock per year, which will free more than 8,000 freight cars and will decrease inefficient hauls by 9.5 million rubles. In addition, construction industry enterprise losses caused by idle time because no rolled stock is available will be decreased by more than 20 million rubles. And there is one more important item. Giant plants do not like to fill orders to produce light-section rolled products, or small-tonnage orders. And yet at the present time light-section rolled stock is in the shortest supply. Therefore new enterprises processing scrap metal are called upon efficiently to service all customers -- construction workers, machine builders, and others.

There are many additional advantages to the new plants and many objective reasons why their construction is an important and warranted move. There cannot be two opinions on this score.

3024
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IMPROVING SCRAP METAL PROCUREMENT

Moscow IZVESTIYA in Russian 27 Jan 81 p 3

[Article by IZVESTIYA correspondents V. Kulagin, B. Prokhorov, and G. Shipit'ko, Ust'-Kamenogorsk-Karaganda-Frunze: "Lull Alternating With Storm: Improving Procurement, Processing and Delivery of Scrap Metal"]

[Text] Vostochno-Kazakhstanskaya Oblast is one of the biggest suppliers of scrap metal in Kazakhstan. Each year more than 140,000 tons of valuable metallurgical raw materials are sent from this oblast to our country's plants.

We encountered senior economist N. Merentsov and administration senior agent I. Volodin in the office of V. Abylgazin, chief of the oblast Vtorchermet Administration. They were looking through preliminary figures on the administration's performance during the past five-year period. Final figures were not yet in, but on the whole results were gratifying.

"The five-year plan has been overfulfilled both in procurement and in sale of scrap metal," stated V. Abylgazin. "We did the best job in the final year of the five-year plan. We generated significantly more profit than in the preceding years."

After a brief pause, however, the administration chief picked up another report and proceeded to say, with an obvious note of alarm in his voice: "But the pace of performance is sometimes quite jerky. Here are figures for the first half of January of this year. Only 1,869 tons of the targeted 12,000 were obtained from enterprises and organizations in this oblast, that is, one sixth. And yet our regular clients count on this raw material -- the Magnitogorsk Metallurgical Combine, the Pavlodar Tractor Plant, the Yermak Ferroalloys Plant, the Tselinograd Vtorchermet Plant, and dozens of smelting shops in East Kazakhstan. Enterprises of the oblast agricultural administration, the oblast Sel'khoztekhnika, and the republic Ministry of Nonferrous Metallurgy are supplying scrap metal in an especially nonuniform manner. The Irtyshsk Complex Ores Combine, for example, has not delivered a single gram of its targeted 347 tons, while the enterprises of Ust'-Kamenogorsk have delivered only 1,298 out of 5,956 tons. And rush work begins at the end of the month and especially the end of a quarter. At these times as many as 300 trucks pile up at the gates of the administration, trucks which wait in line for 5 or 6 hours, although on normal days unloading takes only 15-20 minutes."

"Unfortunately a lack of uniform smoothness is also felt in planning, and in scrap processing equipment supply," stated the administration senior economist. "We are unable to make all kinds of adjustments to the targets. Here is an example. Initially 9,200 tons of scrap metal was targeted for 1980 for the Leninogorsk Complex Ores Combine by the republic Vtorchermet Association. In the second quarter they added 200 tons, 2 months later removed 200 tons, and in the third quarter added 1,000 tons, removing 600 tons in the fourth. And this switching back and fourth happens every year.

'Sometimes obvious miscalculations in planning place scrap metal suppliers in a difficult predicament. For example, M. Labukov, director of the Ust'-Kamenogorsk Metal Structures Plant, shrugged his shoulders in perplexity when we asked him for the reasons why the scrap metal supply target was not met last year.

"'It was incorporated right in the plan,' he explained. 'Judge for yourselves: in 1979 we were targeted for 800 tons with a production schedule of 10,000 tons of metal structures, while in 1980 the same 800 ton target was assigned with a production schedule of 8,000 tons of product. We had great difficulty in bringing both targets into conformity with the enterprise's realistic capabilities for this year.'"

As regards scrap metal processing equipment, the picture is downright depressing. Antiquated presses, shears, scrap breaking unit, chip grinder....

"Their resources have been depreciated three times over," commented V. Abylgazin. "All this miserable equipment is capable of processing only one third of the scrap metal, while we send the rest to our customers 'in bulk.' Freight cars are not fully laden, and we pay substantial fines to the railroad for the underweight. We do not have a single railcar scale. At the republic Vtorchermet Association they say: 'We shall build a processing plant in Ust'-Kamenogorsk, and things will change for the better.'"

They have been promising for many years, but nobody is building this needed enterprise.

The annual target of the Karaganda Vtorchermet shop is approximately 6,000 tons of scrap, and scrap metal procurement and processing could be at least doubled. The state of affairs there, however, is such that the procurement people are scarcely able to cope with the target. There are many reasons for this.

Metal is collected and stored in outdoor areas, where in the winter it can be neither sorted nor baled. The fact is that the presses cannot operate at temperatures below freezing -- the hydraulic drives freeze up. Working conditions generate another problem -- personnel. Skilled workers do not remain here long on the job.

"I am the only engineer-technician personnel left," complained shop chief I. Napreyev. I am doing the job both of the acceptance clerks and the foremen."

For 10 years now they have been talking about building a new shop which would make it possible to resolve many problems so acutely facing the scrap procurers. Even today nobody yet knows when it will be built, either at the republic Kazakhtsvetmet Administration or at the USSR Ministry of Nonferrous Metallurgy, where they have turned for assistance on numerous occasions.

The Saran' Vtorchermet Plant is a modern facility. Its designed capacity is 230,000 tons of scrap metal per year. Its main customer is the Karaganda Metallurgical Combine. The initial plan called for scrap metal to be delivered to the plant, baled, and then to be delivered to the combine by rail, by so-called shuttle consists.

The distance from plant to converter shop is 15 kilometers. Here lies the problem. Railroad regulations state that a distance of less than 200 kilometers is a short distance, and therefore railroaders are not obligated to accept hauling requests. This affects many economic indices.

They resort to all kinds of devices at the plant. For example, they ship metal to the Magnitogorsk Metallurgical Combine, to which the cars are forwarded without hindrance, and then they request that the ladings be reshipped to the Karaganda Metallurgical Combine. And the railroaders are happy to oblige, for penalties are paid by the plant....

An attempt was made to haul scrap metal by truck, but it did not work out. The fact is that the setup for receiving and unloading at the combine is designed only for rail gondola cars. They are well acquainted with this problem both at the USSR Ministry of Industrial Construction and the Ministry of Ferrous Metallurgy. These two ministries are unable, however, to reach a mutual agreement.

D. Kartanov, director of the Kirgizvtorchermet Association, states that unfortunately lack of uniformity in delivery of scrap has become a customary occurrence. In January of last year the facility owed more than three and a half tons of metal, while in December of that year it was clogged with more than 9,000 tons of metal above target. And yet a contract has been concluded with each of the city's 300 enterprises with a scrap delivery target, which specially stipulates that raw material must be delivered uniformly from month to month through an entire quarter. With rare exceptions, nobody adheres to this regulation. And as a result, judging from the figures, for several months the scrap metal facility does hardly any business at all, while in the quarter report months they are working day and night.

"And not everybody delivers scrap," stated Kartanov, displaying a list of enterprises owing metal. It seems that just in the city of Frunze approximately 170 out of 300 enterprises have regularly failed to meet the scrap metal delivery target throughout the entire five-year plan. There are approximately 360 such target-failing enterprises in this republic.

For three years in a row now the Ministry of Motor Transport has failed to meet its scrap metal delivery target, although there is much scrap at the facilities of this ministry. Volunteer inspectors discovered at Bus Depot No 3, for example, 11 rusting buses and mountains of sheet steel and springs.

"Why isn't all this being delivered to Kirgizvtorchermet?"

"This is our repair stock," depot supervisors reply.

And they regularly pay fines for failure to meet the scrap delivery target. Officials at the Kirgizavtomash Plant and the Sokulukskiy Trade Machine Building Plant, and the Kirgiz Worsted-Cloth Combine also pay fines out of the pocket of the state.

In general, one can draw the following conclusion: many Vtorchermet enterprises in Kazakhstan and Kirghizia are failing to do a proper job in planning, procurement and processing of scrap metal. It is a task of primary importance sharply to improve this business. Proper performance on the part of ferrous metallurgical enterprises depends on this in large measure.

3024
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WAYS TO ACHIEVE METAL SAVINGS

Moscow TRUD in Russian 24 Mar 81 p 2

[Article by Hero of Socialist Labor Academician A. Tselikov, general director of the All-Union Scientific Research, Planning and Design Institute of Metallurgical Machine Building Scientific-Production Association, and P. Malinovskiy, laboratory chief at that institute, Moscow: "Metal: Ways to Economize"]

[Text] Metal is the bread of industry. Machine tools, combines, tractors, silverware and penknives -- all these are made of metal. However, in spite of the fact that our country is the world leader in metal production, iron is still in short supply.

Comrade L. I. Brezhnev stated in his Report to the 26th CPSU Congress: "In the new five-year plan large allocations are being specified for development of the metallurgical industry -- ferrous and nonferrous. Naturally we shall be building new metallurgical plants. But there is also another way to overcome the metal shortage -- more skillful and fuller utilization of that which is produced."

The idea is quite clear. We must search out reserve potential. We shall discuss an industry with which our work is closely linked -- machine building. This industry receives a substantial quantity of expensive and short-supply metals, and in particular more than 30 percent of rolled ferrous metals produced in this country.

At the present time a great many of our cars and trucks, tractors, overhead cranes, and excavators are 15-25 percent heavier than the counterpart foreign equipment. The KrAZ-257 truck, for example, built at the Kremenchug Automotive Plant, is inferior to the best foreign models as follows: by 30-40 percent in payload, 15-20 percent in horsepower, and 25-30 percent in fuel economy, although it weighs almost the same as its foreign counterpart.

Here is another example. The caterpillar tractor mounted DP-22 dozer-ripper is built by the Bryansk Road Construction Machinery Plant. It weighs 15 percent more than similar equipment built by foreign companies. Time between overhauls on its engine is less than half, and output is 20 percent less.

What is the problem? The fact is that a shortage of high-quality rolled products forces designers, when designing equipment, to specify materials with understated strength and performance characteristics. That is, excess kilograms are deliberately

"designed into" equipment in order to ensure its reliability. Obviously this leads to an immense overconsumption of metal, which cannot even be calculated. It is difficult to grasp the idea that if a piece of machinery weighs a thousand kilograms, 150-200 of these are "excess," which could well be used elsewhere. What we have here is outright wastefulness. What is the solution? For if we can reduce the metal content in a product we shall be killing several birds with one stone: its cost of manufacture will be less, substantial quantities of metals will be released, and there will be a reduction in consumption of fuel, energy and other material resources.

The solution can be seen primarily in improving the quality of rolled products. In this country we have developed a number of advanced processes which are capable of substantially improving the quality of metal, but unfortunately they are being adopted very slowly.

One of the most effective methods is vacuum treatment of steel. Vacuum-treating molten metal makes it possible to eliminate harmful impurities, which results in a significant improvement in the stress-strain properties of a steel. Employment of vacuum-treated steel makes it possible to reduce metal consumption by 10-15 percent. But this process is expanding extremely slowly in this country. And yet in the 10th Five-Year Plan the Ministry of Heavy and Transport Machine Building was planning to produce each year in the period 1975-1980 from three to four vacuum treatment units. At the same time there were plans to build 18 vacuum treatment units for steelmaking shops currently in operation and under construction. The USSR Ministry of Ferrous Metallurgy specified measures to bring the new units on-stream, with the aim of boosting the volume of vacuum-treated steel production by 1980 to several million tons per year.

A paradoxical situation arose, however. The USSR Ministry of Ferrous Metallurgy specified measures pertaining to bringing this process on-line, but failed to order equipment with the Ministry of Heavy and Transport Machine Building. Thus all the plans remained on the drawing board. Even the vacuum treatment unit built for the Donetsk Metallurgical Plant is standing idle at that facility.

Heat treatment to improve strength is another promising modern metallurgical technique. After heat treatment, steel becomes stronger and more plastic. But industry's requirements in such metal are being met by only 15-20 percent.

The fact is that installations for heat treatment to increase the strength of metal require additional outlays. This is disadvantageous to the Ministry of Ferrous Metallurgy because, although the quality of the product will improve, the quantity in tons will remain the same. The main thing for the ministry is to increase production.

Another important direction for reducing specific metal requirements is to increase equipment productivity to a greater extent than equipment weight is increased. For example, employment of three 800,000 kilowatt steam turbines at a power generating plant in place of eight 300,000 kilowatt units provides metal savings of 3,500 tons.

As was already noted, many pieces of equipment of Soviet manufacture are not only heavier than foreign counterpart units but also have lower operating speeds, poorer

reliability, and lower productivity. Mintyazhmash [Ministry of Heavy and Transport Machine Building], for example, builds units (U2R-600 blenders) for mixing ore, so that it will contain identical percentage content of raw materials. The output of these units is 4-6 times less than counterpart foreign units. The output of the NKR-100 drilling machine is one fifth that of similar foreign-built units. And yet all this equipment continues to be manufactured, in spite of the fact that it has long since become hopelessly outmoded. And yet we currently have similar units which are in no way inferior to the world's best equipment in parameters, but for various reasons this equipment is not being brought on-line or is being adopted very slowly.

At the present time each year an average of approximately 1,500 different items of equipment and devices of obsolete design are retired from production. However, this is a patently inadequate rate of product renewal. A large quantity of obsolete and worn-out equipment is still in operation at ferrous metallurgical enterprises, for example, equipment which produces metal of low quality, with high losses. One would think that it should be replaced as rapidly as possible with new equipment, but in actual fact an infinitesimally small number of units is retired from service each year. At this snail's pace we shall not very soon bring our ferrous metallurgy up to a modern level. New designs must be adopted more vigorously and more rapidly.

Employment of metal-saving processes based on parts rolling mills designed by VNIImetmash [All-Union Scientific Research, Planning and Design Institute of Metallurgical Machine Building] offers considerable potential for achieving metal savings in the machine-building industry. At the present time almost all metal is worked by machine tools. But this converts considerable metal into chips. Parts rolling mills can produce blanks for various shafts, axles, gears, collars and drill bits with practically no waste. Thanks to the fact that the rolled blanks are brought almost fully to the dimensions of the finished part, metal waste is reduced to 2-3 percent in place of the current 27-28 percent. For example, production of railroad car axles by rolling has been adopted at the Metallurgical Plant imeni F. E. Dzerzhinskiy. Savings exceed 20,000 tons of iron per year.

In spite of the advanced nature and great economy, however, adoption of these processes into industry is still taking place extremely slowly. One of the main reasons for this is the fact that the ministries do not want to become engaged in fabricating new equipment, and this equipment is being built and installed only at the initiative of certain enterprise executive officers.

Here is a specific example. We installed at the Chelyabinsk Tractor Plant a mill to roll large gears. Savings are enormous. Labor productivity increased 5-7-fold, and the strength of the produced parts was increased 20 percent. The work force at the Chelyabinsk Plant enthusiastically accepted the new technology, and now seven such mills are in operation there. And yet at the Kama Truck Plant they decided to machine parts by the old, less advantageous, inefficient method. It is downright annoying to encounter such an attitude toward the adoption of advanced techniques. How much money the Kama truck builders would save if they would adopt the new technology! But no -- they like things better the old way.

Our nation's economy is in great need of beams and girders for various roof and ceiling spans, supports, etc. We developed, jointly with the Institute of Electric

Welding imeni Ye. O. Paton, a unit to produce beams by the radio-frequency welding technique. Its output is 350,000 tons of product per year, resulting in a savings of 120,000 tons of metal. All the support documentation was ready five years ago, and yet, in spite of the indisputable advantage of employing welded thin-walled beams, USSR Gosplan and USSR Minchermet [Ministry of Ferrous Metallurgy] cannot yet reach a decision to build the unit.

Such a state of affairs naturally cannot ensure an adequate pace of adoption of advanced technologies in ferrous metallurgy, and consequently growing requirements in high-quality rolled product cannot be satisfied.

At the present time it is much simpler for machine builders to machine parts than to set up waste-free production, for the former technique has already been perfected, adopted, etc. A changeover to new processes requires certain efforts and expenditures. And somehow it is not taken into consideration that the new technique is much more financially beneficial than cutting.

It seems to me that an efficient new innovation should not be dependent on the desire or disinclination of various officials. USSR Gosplan should include the manufacture of parts rolling mills in the production plan of the machine building ministries.

Employment of aluminum is an as yet insufficiently extensively utilized reserve potential for achieving metal savings in machine building. Preference toward production and consumption of aluminum and rolled aluminum products has become a trend in world technological development. Aluminum is present in greater quantities in the earth's crust than any other metal (approximately 8.8 percent), while iron is in second place (approximately 4.65 percent). Therefore aluminum is a very promising metal for the future. It also possesses a number of other advantages over iron: light weight (one third as heavy as iron), a high degree of corrosion resistance, and excellent decorative qualities.

Aluminum and its alloys also possess another important advantage: its strength and toughness do not become diminished as the temperature drops, as is the case with steel. This property opens up the way for extensive employment of aluminum in machinery and structures operating at northern latitudes in this country. The only factor holding back utilization of aluminum is the high cost of obtaining it from ore. It costs three to four times as much as steel. But thanks to the advantages stated above, in many instances employment of aluminum is more efficient than ferrous metals.

The most promising area of application of aluminum alloys is transport machine building, and especially construction of railroad cars, trains, and motor vehicles.

At the present stage a radical improvement in quality and increase in production of efficient metal products is one of the decisive factors in the growth and development of our nation's economy. This thought was particularly forcefully expressed in the Central Committee Report to the 26th CPSU Congress: "The foundation of scientific and technological progress is the development of science. But it is primarily the machine-building industry which can first and foremost open up wide the doors for the new. The machine-building industry is called upon to adopt without delay all advanced innovations created by scientific and engineering thought, and incorporate these ideas into highly efficient, reliable machines, instruments, and production lines.

3024
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POSSIBILITIES FOR INDUSTRIAL APPLICATION OF PLASMA TECHNOLOGY BROADENED

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[Article by N. Basina (Novosti Press Agency): "Fire of 'Cold' Plasma"]

[Text] The most powerful induction plasmotron in the Soviet Union and the world as well has been built and tested at the All-Union Scientific Research Institute of High-Frequency Currents imeni V. P. Vologdin (VNIITVCh). Possibilities for commercial application of plasma technology have greatly expanded with the development of this unit.

Today plasma is used in many applications. In industry there are installations which are in successful operation which cut and weld metal, heat it prior to working, make steel, deposit and spray on various coatings, and do a great many other useful jobs. Nevertheless industry is showing considerable interest in the latest VNIITVCh induction plasma projects, especially in a 1,000 kw plasmotron.

The fact is that in contrast to the conventional arc plasma which is utilized today in the majority of industrial installations, an induction plasma does not become contaminated by electrode combustion products. A second important quality proceeds from the first: since there are no electrodes, they do not have to be replaced, and a plasma induction unit can operate continuously and for a practically unlimited length of time.

In arc units the plasma is compressed into a thin beam and is heated to very high temperatures. An induction plasma is a "cold" plasma -- its temperature does not exceed 11,000 degrees. But even this "low" temperature is quite adequate for the hottest chemical reactions. In addition, in contrast to arc plasma, induction plasma burns in the form of a flare, that is, the working space required for reactions is provided. All this makes industrial plasma units indispensable for obtaining ultrapure chemical compounds, for heat treatment of certain metals, and for conducting continuous or very lengthy chemical and thermal processes. But this far from exhausts their capabilities.

If, for example, a stream of "cold" plasma is run across a concrete construction panel, its unexciting gray surface becomes transformed into something reminiscent of solidified surf. It is both attractive to the eye and extremely practical -- the plasma-"vitrified" panel is stronger and stands up better to weather. In addition, such a process is cheaper than facing panels with ceramic tiles. Units for plasma treatment of concrete panels are being installed at building construction enterprises in Leningrad.

Plasmotrons powered at several dozen kilowatts are employed for such jobs. In principle they are suitable for obtaining the most diversified chemical substances, but product yield will be very low. The new 1,000 km plasmotron will make possible the transition to large-tonnage production of many highly valuable chemical compounds.

Another highly valuable job which can be done by the new plasmotron involves tungsten. This metal is very "stubborn"; it improves its properties only at a temperature of about 2,500 degrees. It is difficult to produce such a temperature in modern furnaces and, if such a temperature is achieved, furnaces will soon break down. An induction plasmotron, however, can handle tungsten without difficulty and can operate, as stated above, practically continuously and during processing does not contaminate the metal with impurities. Plasma annealing of tungsten filaments for vacuum tubes increases their service life many times over.

"Little, but oh so big" -- one recalls this old saying in connection with another potential job to which the new plasmotron can be put. The fact is that this little unit, 1 meter high and approximately half a meter in diameter, is capable of replacing... a blast furnace. If crushed ore is passed through a hydrogen plasma flare, the iron is reduced from the oxides without the participation of coke, huge quantities of which are consumed by blast furnaces. Ordinary water rather than the carbon dioxide gas which blast furnaces eject into the air is a by-product of the plasma process. In addition, the lowest-grade iron ores can be used.

"But this by no means signifies an end to our work," states I. Dashkevich, head of the Department of High-Frequency Plasma and Dielectrics at the institute. "Right now industry needs units which are tens of times more powerful. We are looking for ways to lower the frequency of the power supplies and to develop low-frequency plasmotrons. Our units should become even more productive and economical. Only if this condition is fulfilled can they be utilized on a genuinely mass basis."

3024
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METALLURGICAL AND MACHINE BUILDING INDUSTRY METAL REQUIREMENTS, DEVELOPMENT PROBLEMS

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA EKONOMICHESKAYA in Russian No 5, Sep-Oct 80 pp 79-90

[Article by A. M. Polyak and A. A. Brodov: "Metal Requirements and Problems of Development of the Metallurgical-Machine-Building Complex"]

[Text] Basic proportions in the composition of the metallurgical and machine-building complex are examined taking into account the influence of metalloyemkost' [specific metal requirements, metal content], and in particular the correlation between capital investment in ferrous metallurgy and machine building. The correlation between the production growth rate of leading branches of machine building in value and physical terms is analyzed, and the necessity of accelerated growth of metallurgical machine building is emphasized.

Suggestions are presented on achieving greater efficiency in distribution of functions in the area of forming and shaping metal among branches, in improving the specific structure of ferrous metals, on decreasing the specific designed-in metal requirements in machinery manufacture, as well as a number of other matters connected with improving utilization of metal in the nation's economy.

Under present-day conditions, of the key proportions which determine the scale and pace of growth of this country's economy, the correlation between the levels of development of ferrous metallurgy and machine building is advancing to the forefront. Our nation's economy has now reached a quantitative level in development of production of basic material resources, and ferrous metals in particular, whereby focusing primarily on the extensive mode of satisfying the growing requirements of the materials-consuming branches is economically inadvisable. Comrade L. I. Brezhnev stated, in discussing the problem of improving metal utilization: "We were short of metal when we were producing 50 million tons of steel, and we are also short today, with a production which is almost three times as great. It would be both incorrect and very costly to the economy to resolve this problem solely with quantitative production growth. The qualitative aspect of the matter is acquiring primary significance precisely for this reason...."*

* L. I. Brezhnev, "Leninskim kursom" [Following a Leninist Course], Moscow, Politizdat, 1978, Vol 6, page 149.

The CPSU Central Committee Decree of 8 June 1980 on improving the quality of metal products and efficiency of metals utilization focuses on intensification of production in the area of the metallurgical and machine-building complex.

Intensification of utilization of metal should begin in machine building. Machine building and metalworking account for more than 50 percent of domestic consumption of finished ferrous metal products (rolled stock, steel and cast iron pipe, general metal products, intermediate products, forgings of ingots, steel and iron castings). Precisely for this reason a steady decline in the specific metal requirements in machine-building products is the principal precondition for a higher rate of growth in machine building than in ferrous metallurgy. In the last 10-15 years a ratio of production growth in the metallurgical industry and machine-building industry of approximately 1:2 has become established in the nation's economy: in the period 1966-1978 ferrous metallurgical output increased 1.86-fold, with a 3.93-fold increase in output of machine-building products. Of course one should bear in mind that the dynamics of indices in value terms, especially in this instance, are not equivalent to change in indices in physical terms. In machine building, for example, there has been occurring an increase in the percentage share of so-called repeat count as a result of development of specialization and co-production, and one can observe numerous facts of the cost of machinery and equipment rising more rapidly than the rate of improvement in principal technical parameters and establishment of temporary and one-time prices on product items. We shall cite examples of the correlation of the dyanmics of production indices in value and physical terms for a number of principal machine-building branches for the period 1971-1978. The production growth rate during this period was as follows (%):

In value terms		In physical terms	
Machine tool and tools industry	-- 209	Metal-cutting machine tools	-- 118
Power machine building	-- 165	Press-forging equipment	-- 134
Electrical equipment industry	-- 184	Turbines (million kilowatts)	-- 113
Tractor and agricultural machine building	-- 211	Steam boilers (10 tons of steam per hour)	-- 116
Construction and road construction machine building	-- 179	Electrical machines	-- 164
Materials handling and transfer machine building	-- 167	AC electric motors above 100 kilowatts (million kilowatts)	-- 140
Railroad machine building	-- 158	Power transformers (million kilowatts)	-- 142
Metallurgical machine building	-- 150	Tractors (thousand horsepower)	-- 160
		Grain harvesting combines	-- 114
		Excavators	-- 133
		Bulldozers	-- 135
		Scrapers	-- 120
		Motor graders	-- 143
		Electric traveling cranes	-- 116
		Main-line diesel locomotives (thousand horsepower)	-- 101
		Main-line electric locomotives (thousand horsepower)	-- 143
		Main-line freight cars	-- 119
		Metallurgical equipment (blast-furnace steelmaking, rolling mill, thousand tons)	-- 117

It follows from the above figures that the growth rate of the metals-intensive types of machine-building products in physical terms -- 1.5-6.5 percent per year

for the period in question -- proves to be considerably below the overall rate of production growth of machine building and metalworking -- 10.6 percent. One observes in ferrous metallurgy a considerably greater correspondence between the rate of production growth in physical terms and in value terms. For the period 1971-1978, for example, the overall production growth rate for ferrous metallurgy was 40 percent, while the figure was 31 percent for finished rolled stock, the principal category of commodity output of this branch. In other words, within the "metallurgy-machine building" correlation, the "metallurgical component" is based to a significantly greater degree on the movement of physical indices than the "machine building component." Focusing mach building on end economic results and the scheduled changeover by the branch t roduction planning and record keeping according to a normative net output indicator in conformity with the CPSU Central Committee and USSR Council of Ministers decree of 12 July 1979 entitled "On Improving Planning and Strengthening the Effect of the Economic Management Mechanism on Improving Production Efficiency and Work Quality" will create conditions for greater agreement between the production growth dynamics of machine building output in physical and value terms. However, analyzing the existing correlation between rate of production growth at metallurgical and machine-building plants, one should not conclude on the basis of the above reasons that it reflects the true picture of change in specific metal requirements within the boundaries of the complex in question.

This ratio or correlation can be indirectly characterized with the aid of an investment factor, that is, by the ratio of capital investment . ferrous metallurgy and in machine building and metalworking. This correlation has changed as follows in recent years (%): 1966-1970 -- 44; 1971-1975 -- 34; 1976-1978 -- 28.

Thus capital investment in ferrous metallurgy per ruble of investment in machine building is showing a declining trend. At the same time it would evidently be expedient from the position of the national economy for the ratio in question not to decline, thus creating the possibility of allocating greater funds for improving quality and expanding the product mix in ferrous metallurgy. Of course one could agree with the above-indicated movement in the ratio of capital spending in question if one observed an appreciable growth in production and consumption of other structural materials replacing ferrous metals. However, since ferrous metals are firmly holding to their principal position in the machine building raw materials balance, there are no grounds to assume that a decline in relative capital spending in ferrous metallurgy is adequately compensated by an expansion of capital spending in other industries which produce structural materials.

We shall note that a decline in the share of capital spending in ferrous metallurgy is observed not only within the metallurgical and machine-building complex. Throughout a fairly extensive period of time one has observed a decline in the percentage share of capital spending on growth and development of Soviet ferrous metallurgy also within the framework of industry and the national economy as a whole: from 2.9 and 2.6 percent of overall capital spending in the economy (8.3 and 7.6 percent of capital spending in industry) respectively in 1966-1970 and 1971-1975 to 2.4 percent (7.0 percent) in 1976-1978. Obviously an increase in the percentage share of capital spending in the metallurgical industry both within the framework of the metallurgical and machine building complex and in the national economy and industry as a whole would make it possible to channel additional funding preferentially toward retooling in this industry and improvement of product quality. This

in turn would be an effective instrument for improving utilization of metal and decreasing the specific metal requirements of machine-building products. It would be erroneous to assume, however, that any increase whatsoever in the production of efficient metal products is sufficient. The vaunted "gross output" could proceed to operate here as well: technically there could be achieved an increase in the output of certain economical metal products and structural shapes, while in actual fact they would not be efficiently converted in machine building, for efficient conversion as far as the ultimate consumer is concerned means adoption of new types and varieties of metal in new designs of machinery and equipment manufactured with the employment of new technology.

Let us briefly examine in this connection one point pertaining to the structure of metal consumption which has retained its significance up to the present day -- the question of the percentage share of rolled sheet and plate in the overall finished rolled metal product mix structure. Analysis of the conditions of machinery manufacture and specific metal requirements indicates that employment of sheet steel in place of merchant shapes and the bulk of castings in a large percentage of structures leads to a decrease in the weight of these structures (by an average of 20-40 percent). In addition, waste material in metalworking decreases by not less than 10 percent.

The percentage share of sheet in the finished rolled metals product mix in the USSR has increased by approximately 4 percent in the last 12 years. One could expect that the entire increase in sheet product output should enjoy increased demand on the part of metal consumers. This has not happened, however. In addition, the organizations which distribute metal products have time and again registered the occurrence of "surpluses" of sheet, with merchant shapes in short supply. Such "surpluses" are due to the inadequate preparedness of initial processing facilities in the machine-building industry to transition to employment of sheet. Of course a direct and feedback link exists between production and consumption, and both these aspects of the reproduction process should be examined in an inseparable unity. The impetus to initiate the production of new, advanced products, however, should in the majority of cases proceed from the consumers. As regards the complex in question, we should note that the metallurgical industry is in fact forced to dictate to its customers the scale and rate of growth of the percentage share of sheet metal in the product mix and to "teach" the machine builders to use sheet, overcoming conservatism and inadequate preparedness on the part of a certain percentage of customers.

Comprehensive interbranch efforts are required, both by metallurgists and machine builders, to revise a substantial portion of design and technical documentation for the manufacture of machinery and equipment, with the aim of expanding the scale of adoption of sheet steel in structures and assemblies in place of castings and rolled sections. Coordinated timetables for readying initial processing facilities of the machine building industry to change over to processing sheet steel and development of additional facilities for the manufacture of rolled sheet in the ferrous metallurgical industry should be specified in this effort.

But tasks of coordinating efforts to achieve more efficient materials consumption within the metallurgical and machine-building complex are not exhausted by the above problem alone. Problems pertaining to improving utilization of metal as a whole should be resolved by improving both product quality and product mix in the

"large-scale" metallurgical industry and in metal forming and shaping in the machine-building industry. The problem of finding an optimal distribution of functions pertaining to the forming and shaping of metal between ferrous metallurgy and machine building is one of the most complex. It is closely linked with another fundamental question -- establishment of the most economical consolidated (specific) structure of production and consumption of ferrous metals in the USSR.

The problem of distribution of functions pertaining to the forming and shaping of metal can be illustrated in the following example. In recent years modern large-capacity rolling mills have been steadily coming on-line in the large-scale metallurgical industry, mills with an annual productivity running into millions of tons. For example, the following have come on-line since 1975: the unique custom-built 3600 plate mill has come into full production at the Azovstal' Metallurgical Plant; the high-capacity 2000 continuous wide-strip mills -- a hot-rolling mill at the Cherepovets Metallurgical Plant, and a cold-rolling mill at the Novolipetsk Metallurgical Plant; the world's largest universal girder mill of its type at the Nizhniy Tagil Metallurgical Combine; a 450 large and medium-section structural mill at the Western Siberian Metallurgical Plant, which is capable of producing economical thin-walled sections; a 250-6 high-speed high-output merchant mill at the Krivoy Rog Metallurgical Plant; plus a number of other installations. Standard continuous hot-rolling wide-strip mills have an annual production capacity of 5-6 million tons, large-section and medium-section mills -- approximately 1.5 million tons, and merchant and rod mills -- approximate 1 million tons. With production on this scale, the rolling mill product mix naturally becomes narrower. Rolling of any shapes or dimensions in comparatively small volumes and of complex configuration is economically inefficient on these mills; they should be production-loaded only with mass-consumption sections. It is advisable to roll small (small-scale erection) batches of special sections and shapes on specialized mills. Even on these mills, however, annual output runs into the tens and hundreds of thousands of tons, while requirements in a number of special product items comprise only a few hundred tons.

For the manufacture of product items the technology of which is especially complex and unique, it is advisable to install equipment of special design at machine-building enterprises. The scale of production on special rolling mills should be in conformity with the dimensions of manufacture of principal machine-building products, and any changes in the process of manufacturing principal product items should be considered in the production of castings, forgings and rolled billets. In addition, as a rule equipment for the subsequent processing of rolled semi-manufactures, if needed (equipment for stamping, sizing, etc), should be located here in the immediate vicinity. The economic effectiveness of adoption of special-design rolling mills in the machine building industry is determined by a sharp reduction in consumption of metal (in most cases grade and high-grade), with a large increase in output. As a result, considerable savings are achieved even with a relatively small volume of production.

Thus employment of special methods of rolling semimanufactures in the machine-building industry efficiently supplements the mass production of rolled products in ferrous metallurgy and therefore is of considerable significance to the economy. In this instance delineation of functions in the area of forming and shaping metal is a graphic example of the efficiency of specialization carried out on an inter-branch scale. The economic significance of such specialization will increase with

the increasing adoption of scientific and technological advances in machine building and increasingly complex demands on machine-building technology.

We shall cite a number of examples of efficient forming and shaping of metal in the machine-building industry by pressure shaping. The Soviet bearing industry, for example, has adopted a method of producing bearing races by rolling rod blanks in place of the traditionally employed method of production from bearing tube (prior to that, blanks for large bearing races were fabricated by the smith forging method, whereby the coefficient of metal utilization did not exceed 0.2-0.3).

Processes for rolling gears, sprocket wheels, and even drill bits developed at VNIImetmash [All-Union Scientific Research and Design Institute of Metallurgical Machine Building] are of great significance for the economy.

The manufacturing process of preshaping the teeth of large-module gears by hot rolling makes it possible to reduce metal consumption by 15-20 percent, to increase gear tooth durability by 30 percent, and to decrease labor expenditures by eliminating the rough gear milling operation. In particular, this process has been adopted at the Chelyabinsk Tractor Plant. The economic effectiveness of the process of rolling drill bits is due to a reduction in metal consumption (consumption of high-speed steel is reduced by 25-40 percent in comparison with milling) and an increase in productivity in shaping the drill bit profile (10-20-fold in comparison with automatic drill bit milling machines). Employing rolling to produce ball-bearing balls can increase productivity 2-3-fold over hot stamping and can reduce alloy steel consumption by 10-15 percent. Employment of hot rolling in place of forging blanks for ball-mill balls has made it possible sharply to reduce labor expenditures and cut metal consumption by 20-25 percent.

At the same time in a number of instances (especially in large-series production) it is expedient to produce machine-building industry semimanufactures in the metallurgical industry. Several years ago a 220 cross-screw rolling mill came on-line at the Dneprodzerzhinsk Metallurgical Plant imeni Dzerzhinskiy, to produce railroad car axles. By reducing allowances for subsequent machining, the weight of a rolled axle blank is 10-12 percent less than that of a forged blank produced with the traditional process. When the second unit of the mill comes on-line, hollow axle blanks will be produced, which will decrease their weight even more. To this we must add that the service life of railroad car axles is extended by approximately 20 percent by using the new process. At this point we should note a general factor which is extremely important for the metallurgical-machine-building complex: increase in reliability and durability of machinery and equipment parts and assemblies constitutes a major reserve potential for reducing overall metal requirements, since calculation of the total specific metal requirements of product items presupposes determination of this figure taking into account the service life of these products, that is, including consumption of metal in repair parts.

In addition to improving primary forming and shaping processes in the machine-building industry, substantial reserve potential is retained for adopting advanced process of subsequent processing of blanks. This includes the production of forgings and drop forgings on hot-stamping crank presses, sizing processes, precision flashless stamping, extrusion and upsetting processes, which ensure a high degree of dimensional accuracy and correspondingly a decrease in the volume

and sometimes total elimination of machining. With stamping in sectional die blocks, a metal savings of 20-30 percent is obtained, and an increase in the coefficient of metal utilization to 0.8; hot extrusion of blanks saves 15-20 percent of metal, and the utilization factor increases to 0.7; radial reduction of blanks makes it possible to achieve a 20-30 percent metal savings, boosting the utilization factor to 0.6-0.7; cold closed-die forging saves 15-20 percent of the metal and increases the utilization factor to 0.8-0.9. With cold sheet pressworking the metal utilization factor is 0.75-0.8, and in certain instances is as high as 0.9.

Foundry production is a special field in the area of production of machinery blanks. Advanced areas of foundry production include casting with quick-hardening mixes, pressure-mold casting, pressure die casting, investment casting, chill casting, shell-mold casting, and centrifugal casting. These techniques achieve 10-35 percent metal savings by increasing the dimensional accuracy and homogeneity of the castings and by providing an excellent surface finish.

The production and consumption of ferrous metal castings essentially constitutes one of the major problems in development of the metallurgical-machine-building complex. On the one hand, ferrous metal castings and rolled stock are to a certain degree interchangeable in the manufacture of machinery parts, whereby rolled stock is the principal type of finished product, while iron and steel castings are a "specific" machine-building and metalworking product. On the other hand, the production of finished rolled stock (with preceding metallurgical processes) and the production of castings are for practical purposes based on common sources of iron and waste metal.

At the present time the ratio of production of iron and steel castings to production of finished rolled stock in the USSR is approximately 24 percent. In many machines ferrous metal castings comprise 50-60 percent, including up to 55 percent in rolling mill equipment, up to 80 percent in metal-cutting machine tools, up to 85 percent in caterpillar tractors, and up to 50 percent in hydroturbines. The high percentage share of iron and steel castings in the overall structure of metal consumption is due to a number of factors. In the first place, a shortage of certain rolled products, with output distributed strictly in conformity with allocated resources, provided an objective incentive for machine builders to use castings, which are still not allocated and centrally-normed products. On the contrary, castings are products which, as it were, are part of the system of the "economy in kind" of the machine-building industry. Secondly, there is still at the present time limited employment in machinery and structures of castings of nonferrous metals and alloys, which replace ferrous metals and are utilized with high equivalency factors. Thirdly, the percentage share of the above-listed advanced foundry processes, which produce precision and thin-walled castings, is still small -- as a result the overall weight of rough castings increases. Utilizing the above-noted common raw materials base of ferrous metallurgy proper and foundry production, as well as taking account of the reduced structural metal requirements of product items manufactured of rolled metal in comparison with castings (except for items produced by advanced casting methods), certain changes should be made in structure and areas of metal utilization of the metallurgical-machine-building complex. In other words, in place of the existing approximately parallel growth in production of rolled stock and castings, production of finished rolled stock should

grow at a more rapid pace, while growth in production of castings should be based on precision methods. Allocation and norming of iron and steel castings production must be organized in connection with what has been stated above.

So-called "metallurgical" factors -- improvement in the quality and expanded variety of finished metal products -- continue to occupy an important position in the overall reduction of specific metal content in the products of the metallurgical-machine-building complex. In the Seventh and Eighth Five-Year plans, metallurgical factors accounted for approximately 50 percent of total rolled metal savings in machine building, while in recent years the percentage share of these factors has been targeted somewhat lower (30-35 percent) in connection with enhancement of the role of a number of machine-building areas of metal savings -- design and manufacturing. One should not forget, however, the fact that such a division is arbitrary to a certain degree: for example, improvement in the quality and broadening of the variety of metal products serves as a mandatory precondition for implementation of measures to improve machinery designs and manufacturing processes.

In describing progressive changes in the variety of metal products for the needs of the machine-building industry, it has become traditional to cite general figures on growth of production of efficient ferrous metallurgical metal products, including those which are consumed not only in machine building and metalworking. The most correct procedure is to evaluate the progressiveness of the structure of metal consumption in the machine-building industry according to the degree of employment of efficient "machine-building" metal products. For example, with this aim in mind one should consider growth in consumption in the machine-building branches of total rolled sheet (including heat-treated), bent sections, sized steel, and high-precision merchant shapes. Employment of these categories of metal semimanufactures in the manufacture of products was increased as follows in a number of the leading branches of machine-building production in 1966-1978, from the standpoint of application of this criterion: Ministry of Heavy and Transport Machine Building -- 30 percent; Ministry of Automotive Industry -- 120 percent; Ministry of Tractor and Agricultural Machine Building and Ministry of Machine Building for Animal Husbandry and Fodder Production -- 90 percent; Ministry of Electrical Equipment Industry -- 50 percent, etc (it is true that in spite of this the metal utilization factor in machine building as a whole has remained practically unchanged in the last 10-12 years).

In the period 1976-1978 production was initiated on 357 new hot-rolled and cold-bent rolled shapes, including 86 for the Ministry of Automotive Industry, 53 for the Ministry of Tractor and Agricultural Machine Building, and 42 for the Ministry of Heavy and Transport Machine building. They include special shapes for cultivators and silage harvesters, new leaf spring sections for the automotive and tractor industry, Z-sections, welded closed, perforated, corrugated and other shapes included within the specialization of rolling mills for production on a mass scale. The new shapes are used in structural components of VAZ, MAZ, and KAMAZ trucks, K-700-1 and T-150K tractors, Niva combines and other farm equipment.

Certain work is being done to develop and produce new economical grades of steel. In the period 1977-1978 a total of 45 grades of steel went into production for five machine-building ministries, including 30 grades with improved machinability, as well as a number of high-strength economical alloy steels. Manufacturers have

begun supplying high-strength fasteners for agricultural machine building. Production has commenced on new types of steel pipe and tube, including large-girth shaped tubing (for the Ministry of Tractor and Agricultural Machine Building), including plane-oval and oval sections for propeller shafts and high-temperature corrosion-resistant exhaust pipes (for the Ministry of Automotive Industry).

Considerable changes have been achieved in the manufacture of transformer steels. The percentage share of cold-rolled metal in coils with an electrical insulation coating increased from 28 percent in 1970 to 71 percent in 1978. Specific watt losses of the produced steel have declined. It has become possible totally to eliminate import of metal for the Soviet transformer industry. Employment of Soviet unalloyed steel for designing a new series of electrical machinery with improved characteristics has made it possible to reduce steel consumption by 12-20 percent with equivalent motor production. As a result, in the period 1971-1978, with an 84 percent production increase in the electrical equipment industry, growth in consumption of transformer steels increased by only 30 percent.

In spite of these achievements, however, greater coordination should be achieved in the "production-satisfaction of metal requirements" system. For example, we should note that for this reason some of the rolled sections which have gone into production are not being utilized by the machine-building ministries. Due to a lack of orders, there was no production on 20 shapes developed for the automotive industry, three shapes for agricultural machine building, etc.

At the same time a number of demands of the machine-building ministries connected with increasing efficiency of metal utilization are at the present time not being adequately satisfied by ferrous metallurgy, such as machine-building's requirements in vacuum-treated bearing steel, cold-bent shapes more than 8 mm in thickness, cold-rolled strip 3-4 mm in thickness, annealed merchant shapes for cold upsetting in coils, heat-treatment strengthened steel, clad-metal sheet and merchant shapes, sheet with coatings, shaped tube, and certain other products. This situation was in part due to inadequate supply of equipment for expanding production capacities at metallurgical plants. In other words, an effective means of eliminating these disproportions can be found within the metallurgical-machine-building complex proper: if machine building increases the manufacture of specialized types of equipment for the metallurgical industry, it creates the preconditions for improving its own supply of metal of the requisite inventory.

Let us briefly examine the correlation between production growth in finished rolled products and metallurgical equipment in recent years. In the period 1971-1978 production of finished rolled stock rose by 31 percent, and metallurgical equipment (in thousand tons) by 17 percent, including an 8.5 percent growth for rolling mill equipment (including machinery and equipment for continuous casting of billets). In other words, the rate of metallurgical equipment production growth was running at only slightly more than half the finished metal products growth rate, while the rolling mill equipment production growth rate (that is, equipment for metallurgical processing, where the basic preconditions are created for improving the quality of the metal which goes into the finished product) in turn proved to be half that of the overall rate of metallurgical equipment production growth (it is true that the latter may be due in part to import of certain types of rolling mill equipment). The task of increasing the supply of requisite equipment

to the ferrous metallurgical industry, especially equipment for continuous casting, rolling mill operations, and final product finishing operations, clearly proceeds from the above. To achieve this, there should occur a substantial increase in the percentage share of metallurgical equipment in the total production of heavy machine building plants (it is even less than 50 percent at a number of leading Soviet heavy machine building enterprises), and new specialized facilities should be built for the manufacture of equipment for ferrous metallurgy.

We noted above the necessity of making more efficient the processes of forming and shaping metal, with optimal distribution of functions in this area between metallurgy and machine building, and accelerated adoption of advanced methods of metal processing as important factors in reducing overall metal requirements of the metallurgical-machine-building complex. To this we must add the task of reducing the structural metal content (net weight) of machine-building products by employing more sophisticated design solutions, including application of new basic equipment operating principles, more precise methods of engineer calculations for machinery parts and assemblies, with elimination of excessive safety factors, improvement of equipment functional operating layouts, with incorporation of hydraulic and pneumatic drives in place of large and high metal-requirements electromechanical drive, etc.

In recent years machine builders have done a considerable amount of work in the area of implementing advanced design solutions, improvement in the weight characteristics of individual parts and assemblies, employment of a number of efficient iron and steel substitutes, as a result of which the specific materials requirements and especially the metal requirements of many product items have appreciably declined. For example, the specific metal content in turbines and diesel locomotives has declined by 20-30 percent, trucks -- by 16.5-20 percent, tractors (on the average) -- by 9.5 percent, diesel engines and diesel generators -- by 15 percent, boxcars -- by 5.5 percent, tower cranes -- by 17 percent, multiple-bucket excavators and mechanized units -- by 16 percent, and metallurgical machinery and equipment -- by 15-17 percent. Specific metal requirements of Soviet power equipment is in conformity with the counterpart figure for similar equipment manufactured abroad; in particular, the generating capacity of a nuclear power station generator unit manufactured in the USSR has more than doubled without a substantial increase in size (that is, absolute metal content), by improving design and metal quality. At the same time there are many examples of manufacture of machinery and equipment with excessive metal designed in. For example, according to available data, the EO-6121 excavator produced by the Ministry of Construction, Road, and Municipal Machine Building weighs 9 tons more than justified by the level of advanced Soviet and foreign standards, while the KB-405-2 tower crane exceeds its counterpart by 26 tons in metal content. Thus a decrease in the designed-in metal requirements of machinery and equipment constitutes a major reserve potential for achieving an overall decrease in metal consumption in the metallurgical-machine-building complex, the significance of which is increasing year by year. We must note, however, that the significance of precisely this reserve potential is sometimes not perceived by our managers and specialists in full measure. A system of distribution of metal products has now been set up in this country, which takes into account metal savings from expanding the adoption of efficient types of metal to replace traditional metals on the basis of centrally ratified substitution or savings factors (for example, in allocating low-alloy metal resources, their weight is reduced by 20-30 percent in comparison with carbon

steel, employment of heat-treatment untreated rolled stock in place of strengthened steel reduces the weight of consumed metal by 20-25 percent, etc). The question of adopting planning of rolled metal utilization factors by machine-building branches is practically settled. At the same time, the equally important question of establishing centralized (at the ministry level) standards and targets for reducing specific structural metal content (including rolled stock, pipe and tube, general metal products, further-processed products, castings, forgings from ingots, that is, all categories of metal products) of machinery per unit of a machine's basic technical parameter has not yet been resolved.

Successful development of this country's metallurgical-machine-building complex in the direction of reducing product specific metal requirements demands the creation of new organizational forms of cooperation among enterprises, scientific research and design institutes, as well as design offices of the branches involved in this complex. In this connection we should not minimize the importance of dissemination of the advanced know-how of the enterprises, scientific research and design organizations in Chelyabinskaya Oblast, which are proceeding in a deliberate manner to economize in metal, to improve metal quality, to reduce the metal requirements of machinery and equipment, and to improve manufacturing processes. Organization of the process of creation of the products of the metallurgical-machine-building complex along the entire industrial chain: institute-metallurgical plant-enterprise-customer -- has been adopted in a practical manner. This ensures overcoming interministerial obstacles and a closer coalescing of science and production. For example, combined teams of the Institute of Ferrous Metallurgy (Dnepropetrovsk), the Magnitogorsk Metallurgical Combine, the AvtoZIL Association and the Chelyabinsk Press Forging Plant have developed new grades of steel for deep stamping, which has made it possible to reduce tens of times over rejects occurring in the manufacture of a number of critical components.

Joint work by scientists at the Chelyabinsk Scientific Research Institute of Metallurgy, specialists and workers at the Chelyabinsk Metallurgical Plant and Volga Automotive Plant has led to the development and adoption of a unique process of alloying steel with lead or calcium addition agents. This has made it possible sharply to improve the machinability of steel, as a result of which tool durability in the high-speed machining of such new grades of steel has increased 5-10-fold. Annual savings obtained thanks to this project, according to calculations by experts at the Volga Automotive Plant, total 1 million rubles. As a whole, the experience amassed by the Chelyabinsk people in the area of mapping out a large-scale scientific and technical program for achieving end results benefiting the economy should be viewed as a new approach to solving the problem of achieving metal savings.

Thus an analysis of the principal problem of reducing specific metal requirements -- one of the central characteristics of development of the nation's economy at the present stage -- enables one to reach the following conclusions:

resolution of these problems is possible only through their coordinated examination within the framework of this country's metallurgical-machine-building complex;

a focus on the end result to the nation's economy is the foundation of such a solution: manufacture of a maximum number of serviceable machines with the desired technical-economic parameters from the available resources of metal of specified quality;

calculation of the actual rate of decrease of specific metal requirements demands preparation of appropriate amendments to the dynamics of machine-building and metalworking product output indices in value terms;

change in the structural proportions of capital investment in the metallurgical-machine-building complex and in industry as a whole in the direction of boosting the percentage share of capital expenditures in ferrous metallurgy (in particular, on measures to improve product quality) can be recommended in coming years;

greater efficiency in distribution of functions in the area of forming and shaping metal between ferrous metallurgy and machine building [illegible] of the basic reserve potentials for reducing specific metal requirements, although there is no universal principle in operation here: the specific features of the forming and shaping process and the assigned task pertaining to utilization of finished product items should in each instance determine the sphere of application of this process (metallurgy or machine building);

decrease in the structural metal content (net weight) of machinery and equipment per unit of their principal technical parameter is another important reserve potential for achieving metal savings, implementation of which requires centralized preparation of standards and targets in this area;

improving quality and broadening the product mix in ferrous metallurgy maintains its primary significance for satisfying the needs of the metallurgical-machine-building complex, but the principle of the vaunted "gross output" should not operate here either: any increase in the production of advanced types of metal should be coordinated with the machine builders in order to achieve efficient processing of additional quantities of these metal products;

expansion of the production and consumption of sheet steel and restriction of the rate of growth of employment of castings (except for high-precision and thin-wall lightweight castings) in machine building should in this connection be supported by elaboration of a comprehensive interbranch program to improve these major structural proportions of metal consumption;

the experience of the enterprises and organizations of Chelyabinskaya Oblast in the area of achieving metal savings, which specifies coordinated interbranch work on the scheme "institute-metallurgical enterprise-enterprise-metal customer" is at the present time the most valuable adopted organizational form of work to reduce specific metal requirements within the framework of the metallurgical-machine-building complex.

3024
CSO: 1842/63

UDC 521.6

EXPERIMENTS WITH METALLIC MATERIALS ON THE SALYUT-6 - SOYUZ ORBITAL STATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 81
pp 59-64 manuscript received 29 Dec 79

IVANOV, L. I. and PIMENOV, V. N., Moscow

[Abstract] The studies here described, performed on the Salyut-6 space station, are a continuation of the study of the effect of weightlessness on the kinetics of the process of formation of phases from liquid solutions begun in the Soyuz-Apollo project. The effect of weightlessness on processes of melting and crystallization of metals which either can or cannot mix with each other in the liquid state, the interaction of liquids and solids and capillary effects were also studied. The studies were performed on Al-W, Cu-In, Al-Cu, Al-Pb, Al-Sb, Su-Sn and Al-Sn-Mo materials. All experiments were performed on the "Splav-01" installation, involving heating, holding, and slow and rapid cooling. Photographs of specimens produced in this manner are presented. The dimensions of the secondary phase particles produced in space were significantly larger, and there was of course no gravitational segregation. During crystallization of liquid systems, it was found that the eutectic formed is primarily platelike and columnar in shape. The dispersion of the eutectic in the space specimens was generally somewhat higher than on earth, and the αAl-solid solution is found both as circular particles and as large dendrites. When metals which are immiscible in the liquid state were crystallized (studied using Al-Pb), the Al was segrated as a sphere within the Pb, though in some small volumes at the boundary both components were present. The study of the influence of weightlessness on the interaction between solid and liquid metals indicated that the diffusion layer in space flight specimens of Cu-In and Cu-Sn was more homogeneous in thickness and phase composition than earth specimens, while the diffusion boundary between the copper and the layer followed the profile of the initial external copper cylinder used. A study of the filling of capillary channels in copper with liquid tin and indium showed that the filling of the channels with the liquid metal and its diffusion interaction with the walls formed a solid-phase layer. The rate of formation of this layer and its homogeneity were both significantly greater than on earth. Figures 5; references 8: all Russian.
[46-6508]

UDC 669.715:621.77

GRANULAR METALLURGY - A METHOD OF IMPROVING THE QUALITY OF METALS AND OF UTILIZING THEM MORE EFFICIENTLY

Moscow TSVETNYYE METALLY in Russian No 3, Mar 81 pp 17-20

BELOV, A. F.

[Abstract] The production of nonferrous metals (aluminum, copper, titanium) and nickel has increased remarkably over the past 40 years in capitalist countries, but the Soviet Union has become the leader in production of titanium and nickel. The important factors in the production of nonferrous metals are maximum utilization of the extracted material with minimum expenditure of fuel and energy, at minimum labor and tooling cost. Notable contributions in this area were made by the Russian scientist D. K. Chernov, who originated the concept of compacting a cast metal through elimination of internal voids by mechanical means, and by the Soviet scientists A. A. Bochvar and A. G. Spasskiy, who developed a crystallization process under hydrostatic gas pressure. Knowledge acquired since then has led to the development of granular metallurgy, essentially involving a fast solidification of small droplets of molten metal during crystallization and compaction under isostatic pressure. This technology will soon be available for production of turbine disks from heat-resistant nickel alloys. A typical necessary cooling rate of 10^6°C/s is attainable only in extremely small volumes, droplets approximately 20 μm in diameter, and compaction under a pressure of 100-200 MPa during heating to 1200°C should yield a metal of the theoretical 100% density. The technology can also be adapted to semifinished products of titanium alloys and aluminum, as well as to compactic of articles with internal defects. A modification of this technology would be hot isostatic compression, particularly applicable to dispersion-hardened alloys and even various ceramics.
[81-2415]

UDC 539.612:678.742.23:669.018

APPLYING THE METHOD OF MOLECULAR LAYER DEPOSITION TO IMPROVE THE ADHESION OF POLYMERS TO A METAL

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 6, 1981 pp 1443-1446
manuscript received 15 Sep 80

SOKOLOV, B. D., SMIRNOV, Ye. P., KOL'TSOV, S. I. and ALESKOVSKIY, V. B., corresponding member, USSR Academy of Sciences

[Abstract] A study was made to determine the effect of chromium-(VI) oxide, added by the method of molecular layer deposition, on the adhesion between a metal surface and a polymer. Surfaces of aluminum and grade-3 steel were coated with grade 108020-020 low-density polyethylene by rolling at 170-250°C. The adhesion strength was measured by the peel method (90° angle). The adhesion

strength, initially 0.30-0.38 kgf/cm for both metals without chromium oxide, was found to increase gradually as monolayers of chromium oxide were added and to peak at 1.20 kgf/cm with four monolayers on aluminum or at 1.87 kg/cm with four monolayers on steel. Adding more monolayers of chromium oxide did not increase the adhesion strength in the case of aluminum and even decreased it slightly in the case of steel, owing to the shielding effect of the lower monolayers. While immersion in water reduced the adhesion between polyethylene and both metals without chromium oxide to zero within four hours, addition of up to four monolayers of chromium oxide maintained it in water for at least 10 days. Figures 3; references 15: 13 Russian, 2 Western.
[59-2415]

UDC 548.162:5.39.3

GROWTH OF FILAMENTARY CRYSTALS ON ALUMINUM FOIL SURFACE

Sverdlovsk FIZIKA MATALLOV I METALLOVEDENIYE in Russian Vol 51, No 1, Jan 81 pp 108-114 manuscript received 23 Feb 79

KOLESHKO, V. M. and BELITSKIY, V. F., Institute of Electronics, Belorussian Academy of Sciences

[Abstract] The results of analysis of the growth of filamentary crystals on the surface of thin film conductors of microwave transistors are presented. The experiments were conducted on test structures that failed as a result of extended operation. The current-conducting aluminum interconnections were 2 microns wide and 1.2 micron thick. The current density in interconnections was maintained at about 10^6 A/cm^2. Surface analysis of thin film conductors was carried out on an electron probe x-ray microanalyzer in the scanning electron microscope mode. The investigations revealed that the filamentary crystals are whiskers that grow upward, reaching a height of 10 microns and more with a thickness of 1-2 microns. The experimental results show different basic stages of whisker growth: an incubation period, growth at some constant rate, and cessation of growth and collapse of the filamentary crystals. The whiskers are nucleated from the liquid phase. Surface defects of aluminum and silicon dioxide films, related to mass transfer under the influence of internal mechanical stresses, are analyzed. Liquid zones are formed and whiskers grow from them due to fluctuation of local current dencity on structural defects. Figures 4; references 14: 9 Russian, 5 Western.
[62-7872]

UDC 537.312.62+621.316.540

SUPERCONDUCTING PULSED SOLENOID SWITCHED BY THE 'ELECTRIC EXPLOSION' METHOD

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 5, 1981 pp 1119-1122
manuscript received 4 Aug 80

ANDRIANOV, V. V., BAYEV, V. P., LEBEDEV, S. V. and SAVVATIMSKIY, A. I., Institute of High Temperatures, USSR Academy of Sciences, Moscow

[Abstract] The exploding wire method can be used to switch currents rapidly, a frequent requirement in superconductor experimentation. However, if the current density in the wire is high enough to cause the wire to explode into very small droplets, necessary to achieve good dielectric strength of the explosion products, the switching speed may be too fast for successful interaction with mechanical switching equipment. If the current density is low enough to allow relatively slow switching, the explosion products are much larger droplets of metal, without sufficient dielectric strength. A solution is to enclose the wire in a capillary tube of a nonconducting material, resulting in high vapor pressure of the material when the wire melts, preventing arc formation and achieving the desired switching speed. This method was used in a switching circuit for a superconducting pulsed solenoid, describe in this article. The copper wire in the capillary tube, connected in parallel with rapidly opened mechanical contacts, achieved stable disconnection of the current of about 1 kA at up to 60 kV. Parallel connection of additional tubes with exploding wires could break even larger currents and voltages. Figures 3; references 6: all Russian.
[44-6508]

UDC 539.89

HIGH PRESSURE AND HIGH TEMPERATURE APPARATUS WITH A LARGE REACTION VOLUME FOR A 50,000 TON PRESS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 4, 1981 pp 852-855
manuscript received 9 Oct 80

SEMERCHAN, A. A., DUZIN, N. N. and DAVYDOVA, T. N., Institute of High Pressure Physics, USSR Academy of Sciences, Troitsk, Moscow Oblast

[Abstract] A description is presented of high pressure apparatus with a working volume of 86.8 cm^3 designed to operate with a 50,000 ton press. The peripheral portion of the die used in the new apparatus is made of high quality heat treated steel, reducing the need for the tungsten carbide hard alloy used for the center, improving the strength properties of the hard alloy portion of the die and increasing the pressure achieved in the large volume reaction vessel. The main difficulty of this method is that when the pressure is created the preliminary interference fit of the hard alloy portion of the die in the steel ring is reduced

due to the radial stress arising as the material of the seal flows from the circular cavity of the third stage outward. This results in cracking of the hard alloy and failure of the apparatus. This is avoided in the present device by constructing the surrounding steel rings with conical surfaces so that as the die is forced into the rings the radial pressure is increased. Another apparatus is currently under construction with a reaction volume of about 200 cm^3, which should be capable of synthesizing diamond powder in a press with a force of at least 10,000-12,000 t. Another apparatus with dies made not of hard alloys but rather of heat treated high quality steel will have a volume of about 840 cm^3, reaching pressures of 80-100 kbar. Figures 4; references 3: all Russian.
[53-6508]

UDC 669.017.620.1:535.21

LASER CONTROL OF THERMOCHEMICAL PROCESSES AND OPTIMAL LASER HEATING OF METALS IN AN OXIDIZING MEDIUM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 256, No 4, 1981 pp 848-852
manuscript received 31 Jul 80

BUNKIN, F. V., corresponding member, USSR Academy of Sciences, KIRICHENKO, N. A., KRASNOV, I. V., LUK'YANCHUK, B. S., SHAPAREV, N. Ya. and SHKEDOV, I. M., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Methods of the theory of optimal control are used to find a time profile of a laser pulse designed to minimize the energy expenditure in heating of a metal in an oxidizing medium by laser radiation. It is demonstrated that the profile of the pulse can be approximated by a combined (continuous plus pulsed) mode of irradiation. Two-pulse heating is mathematically analyzed considering both convection and the evaporation of the oxide film on the metal, as well as interference phemonena in the oxide-metal multilayer structure. The optimal mode is described by an equation, and results in an energy expenditure 35% less than in the best single-pulse mode, and 15% less than in the best two-pulse mode. Figures 2; references 10: all Russian.
[53-6508]

UDC 621.73.073

USE OF ELECTRIC-SLAG REMELTING IN THE PRODUCTION OF BLANKS FOR FORGING STAMPS

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 2, Feb 81 pp 15-16

NIKUYKO, I. S., TIMCHENKO, Ye. I., KOSHELEV, B. V., ZHDANOV, A. I. and GNUTOV, Ye.M.

[Abstract] The Volgograd Scientific Research Institute of Heavy Machine Building in cooperation with various plants in this branch of industry has developed and introduced to production a technology and installation for electric slag remelting

for the production of casting blanks for forging stamps, to replace the traditional forging cubes. The electrodes are made of used stamps. They are cut or forged into bars, then electroslag welded into an electrode of the required design length of 5000 to 8000 mm. The electrodes are remelted under a layer of melted refining flux in a water-cooled crystallizer. The cast metal produced by this method is free of various inclusions and liquation and shrinkage defects. The process is remotely and automatically controlled. Advantages of the new process include reutilization of stamping steel, an increase in the life of stamps by 30 to 50% due to an improvement in the quality of the metal, production of steel of the required chemical composition by the use of bars made of alloy steel wastes available at the enterprise, and production of stamp blanks of the proper shape. Use of electroslag remelting at three plants has resulted in a savings of 924 tons of type 5KhNM steel, liberation of 22 persons and an annual savings of 565,000 rubles.
[74-6508]

UDC 621.791.89

KINETICS OF THE JOINING OF MATERIALS IN THE SOLID PHASE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 81 pp 75-85
manuscript received 24 Apr 80

SHORSHOROV, M. Kh. and DRYUNIN, S. S., Moscow

[Abstract] The authors attempted to derive the basic relationships of the kinetics of the process relating the growth in strength of a joint with such parameters as temperature, time, pressure and others, based on the theory of topochemical reactions in the condensed state. This study is important, since the kinetics of formation of a fire joint between fiber and matrix must be studied for the production of strong composite materials. The kinetics of formation of a physical contact and formation of interaction centers resulting in the formation of a joint are described mathematically. Experimental examples are presented. The applicability of the general kinetic equation of the formation of a strong joint of material in the solid state is demonstrated for conditions such that strong centers of the joint are formed and the centers grow, after the formation of new centers stops at a certain point in time. It is demonstrated that the kinetics of strength may have several stages even if the strength curves appear smooth. Figures 5; references 13: all Russian.
[66-6508]

UDC 541.183

NUCLEATION IN CHEMICALLY REACTING MEDIA

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 81
pp 65-68 manuscript received 5 Jun 80

FEDOROV, V. B., KALASHNIKOV, Ye. G. and SHORSHOROV, M. Kh., Moscow

[Abstract] Nucleation is studied considering topochemical reactions which reduce surface energy. The system studied consists of a solution of a surface-active substance in a metal containing a liquid and a dispersed solid phase. The introduction of the surfactant effectively increases the nonequilibrium nature of the solution. A simplified description of the kinetics of the phase transition is presented and the conditions of mechanical stability of clusters of the new phase are discussed. It is determined that if there is anisotropy of surface energy, the adsorption pressure on different faces of a crystallite will not be the same, influencing the rate of growth of these faces. This explains the dendritic growth of crystals from melts when surfactants are present. Figures 1; references 3: all Russian.
[46-6508]

UDC 669.15'295:535.3

OPTICAL PROPERTIES OF THE INTERMETALLIC COMPOUND Ti-Fe

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 50, No 5, Nov 80
pp 976-983 manuscript received 24 Apr 79 in final version 24 Sep 79

SASOVSKAYA, I. I., Institute of Metal Physics, Ukrainian Scientific Center, USSR Academy of Sciences

[Abstract] A study is made of the optical properties of polycrystalline Ti-Fe over a broad spectral range (0.25-17 μm, 0.07-5 eV). The data obtained are compared with calculations of the electron energy spectrum of Ti-Fe as well as experimental optical data for Cr. The optical constants n and k of Ti-Fe are presented in a table. They are used to calculate the true and imaginary parts of the complex dielectric permeability, high frequency conductivity and reflectivity. Analysis of the results obtained shows that although the optical properties of Ti-Fe are qualitatively in agreement with contemporary concepts of its zone structure, there are significant divergences between the calculations and optical experiments which indicate the need for further study of the models of the electron structure of this compound. Figures 4; references 7: 1 Russian, 6 Western.
[67-6508]

UDC 620.172.24

FEATURES OF THE FRACTURE OF METAL CERAMIC TUNGSTEN AT VARIOUS TEMPERATURES IN A VACUUM

Kiev PROBLEMY PROCHNOSTI in Russian No 1, Jan 81 pp 79-82 manuscript received 10 Apr 80

USKOV, Ye. I. and BABAK, A. V., Institute of Strength Problems, Ukrainian Academy of Sciences, Kiev

[Abstract] A study of the temperature variation of the fracture toughness characteristics of metal ceramic tungsten revealed some features of the fracture of this material. The tests were performed on specimens of technical tungsten with partially polygonized structure obtained by high-temperature rolling and annealing of sintered blanks. The studies were performed on the VURT-1 installation for the study of characteristics of fracture toughness of refractory materials at high temperatures under a vacuum, developed at the authors' institute. The specimens were heated by radiation at 1°C/sec, then held at the test temperature for 30 minutes before tensile testing. Metallographic analysis of the test specimens showed that the fracture characteristics are determined by the peculiarities of fracture of the specimens in each temperature range. Photographs of fractures are presented. Brittle fracture was observed throughout the temperature range, but the nature of processes of transcrystalline and intercrystalline fracture varied with temperature. At room temperature the cracks may start through crystals, but continue to propagate along grain boundaries. As the temperature rises to 200°C, crack growth occurs entirely along grain boundaries. At still higher temperatures, plastic deformation increases, and secondary cracks begin to appear. At 600°C, fracture is primarily due to intercrystalline growth of the initial crack. At 800-1200°C, fracture occurs primarily due to cracking between grains. At 1600°C, intercrystalline crack growth is the primary mechanism of fracture. Figures 3; references 2: both Russian.
[47-6508]

UDC 669.721'884'73'71

ISOTHERMAL SECTIONS OF THE Mg-Li-Cd-Al SYSTEM IN THE MAGNESIUM-RICH AREA

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 6, Nov-Dec 80 pp 230-234 manuscript received 5 Nov 79

DRITS, M. Ye. and GUZEY, L. S., Moscow

[Abstract] Isothermal cross sections are constructed for the Mg-Li-Cd-Al system passing through the binary alloys Mg-10 wt.% Cd, Mg-21.66 wt.% Li and Mg-21.66 wt.% Al. The alloys were prepared in corundum-lined crucibles beneath a flux of 80% LiCl plus 20% LiF (by weight) of high purity magnesium, electrolytic lithium with not over 0.02% sodium, A99 aluminum and high purity cadmium cast in a copper chilled mold, then upset at 320-330°C in a 160-ton press with 50% height reduction.

Trinary state diagrams are presented, showing the presence of the magnesium and lithium solid solutions $Mg_{17}Al_{12}$ and AlLi. Figures 2; references 7: all Russian. [50-6508]

UDC 669.245-151:536.42

SPECIFICS OF STRUCTURAL TRANSFORMATIONS OF REFRACTORY NICKEL ALLOY IN THE PROCESS OF HIGH TEMPERATURE HEATING

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 6, Nov-Dec 80 pp 190-194 manuscript received 5 Jul 79

KISHKIN, S. T., KULESHOVA, Ye. A., LOGUNOV, A. V. and PETRUSHIN, N. V., Moscow

[Abstract] A study is presented of the structural changes in an alloy in the system Ni-Cr-Co-W-Al-Ti-Nb-Hf (Ti=2.5 at.%, Nb=0.8 at.%, Hf=0.2 at.%, W=3.8 at.%, C=0.8 at.%, quantity of carbide phase in alloy 3 wt.%) in the process of heating from room temperature to the melting point, as well as its phase composition, particularly the ($\gamma'+\gamma$) eutectic and the Ni_3W_3C-type carbide. The phase composition was studied on a monolith by microprobe analysis. The microstructure features large inclusions of two types in the γ-solid solution. Large formations of the excess phase were found to be eutectic colonies. A difference was observed in the γ' phase in the eutectic and located in the interdendritic space from the γ' phase formed upon decomposition of dendrites of the γ-solid solution, probably caused by liquation of the alloy elements. The results of resistometric and phase analysis as well as high temperature optical microscopy allow an evaluation of the portion of the pseudo-binary diagram of the alloy. It illustrates that the solubility of the γ' phase remains practically unchanged from room temperature to 1070°K, while the solubility of the γ' phase increases with increasing temperature between 1150 and 1540°K, then remains practically unchanged up to the solidus temperature of 1580°K. Figures 3; references 10: 6 Russian, 4 Western.
[50-6508]

UDC 669.27.24:620.186.5

TENDENCY TOWARD RECRYSTALLIZATION OF A PRECIPITATION-HARDENING TUNGSTEN WIRE IN CONTACT WITH NICKEL ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 80 pp 38-40

ISAYKIN, A. S., DVOYCHENKOVA, L. V., CHUBAROV, V. M., SAVCHUK, A. N. and BALIKHIN, V. S.

[Abstract] VT-10 and VT-15 tungsten alloy wire (0.5 mm in diameter), strengthened with zirconium carbide and nitride, were tested as to their interaction in

ZhS6U and EI435 nickel alloys. To evaluate the tendency of recrystallization of the wires they were annealed at 1200-1450°C for 10 hours and two minutes, respectively. At 1200° all the tungsten alloys retain their initial structure but at 1450° the W-Zr-N alloy showed the start of recrystallization in the center part. Tests results showed that in all the composites the fibers retained their initial structure except those of the W-Zr-N system in contact with ZhS6U alloy. A comparison of the recrystallization rate of VT-15 tungsten fibers at 1200°C with the corresponding rates for fibers of W-Re-Zr-C, W-Zr-C and W-Zr-N lead to the following conclusions. The recrystallization temperature of W-Re-Zr-C in contact with the nickel alloys is less than with VT-15 tungsten. For the other tungsten alloys this difference was even more significant. The recrystallization process in fibers of the W-Zr-C and W-Zr-N alloys is very sensitive to surface defects in the fibers. The presence of Re in the one tungsten alloy seems to promote obtaining a higher-grade surface on the fibers which has a significantly lower rate of recrystallization than the other alloys. It was not found possible to use tungsten with precipitation-hardened zirconium carbide and nitride in a nickel alloy matrix without developing a diffusion barrier for the reinforcing fibers. Therefore a solution to the problem was found during experimentation which is to apply a protective coating of tantalum, 5-15 microns thick, on the tungsten wire by electrolysis of a melt of tantalum salts. Figures 3; references 4: 2 Russian, 2 Western.
[54-6468]

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